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NEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

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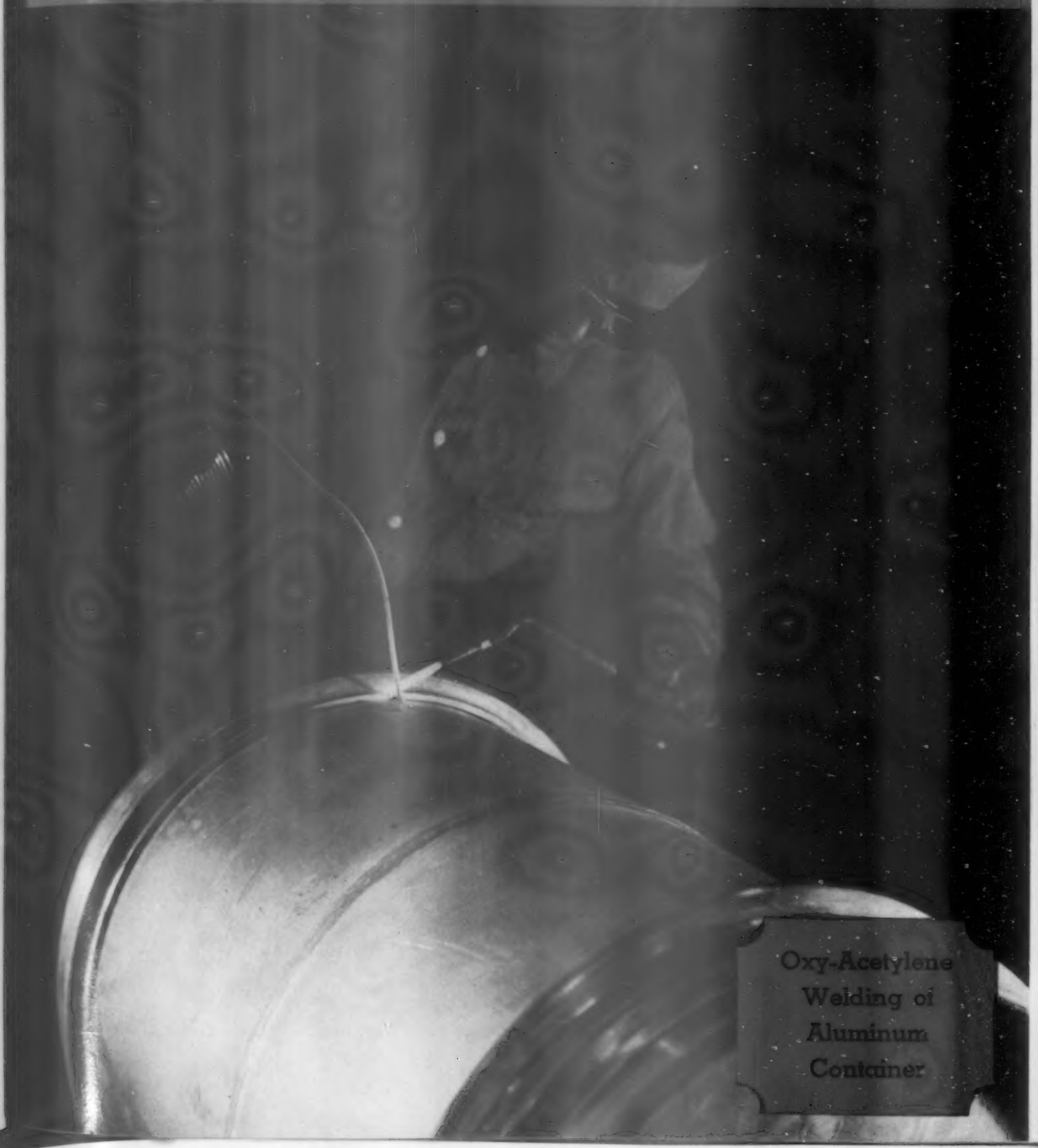
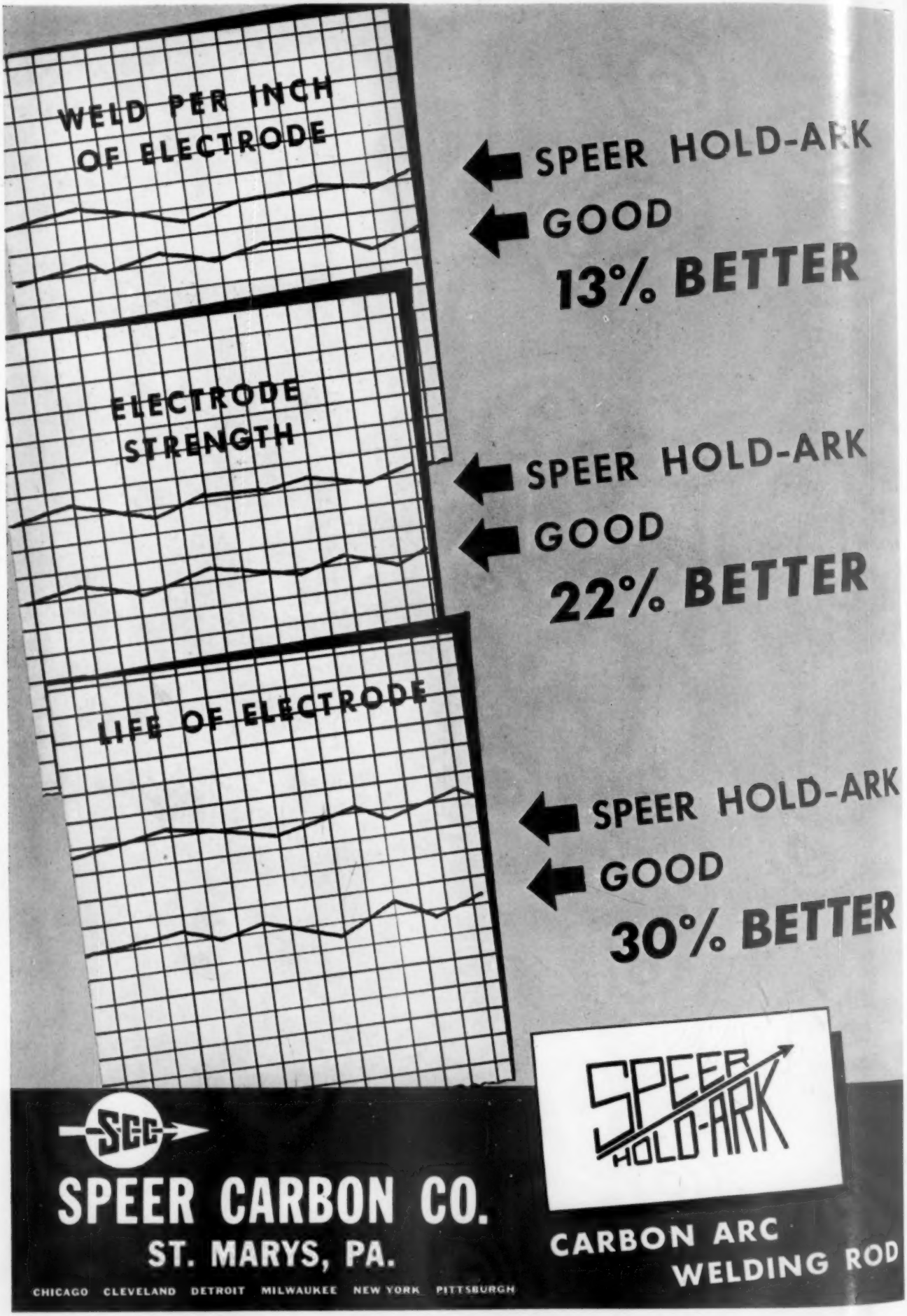


Oxy-Acetylene Welding of Aluminum Container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The Welding Engineer

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Many manufacturers are adopting low-priced welders for light work to gain savings in over-all welding costs and to release larger machines for heavier production work.

Some manufacturers who have hesitated to invest in larger machines for maintenance work find that the low price of this welder justifies keeping it on hand for emergency repairs.

Stored-Energy Welding

THERE IS MORE than one way to skin a cat, according to an overworked and time-worn phrase. Nowhere is this more true than in welding. The fabricators of high-conductivity metals and alloys have encountered considerable difficulty in spot welding and seam welding of the copper-base and aluminum alloys. The alloys of aluminum have critical melting points which necessitate that the welding energy be supplied with extreme accuracy. Obviously, this is not a simple job with conventional spot welding equipment, because the energy is expended in a very short period of time and any errors in weld timing will be likely to cause an inconsistency in weld quality. In the spot welding of high-conductivity materials, using conventional equipment, the power demand is extremely heavy, but even more important, it is disagreeably intermittent in its application. Not only does this lead to interference with other power-consuming equipment, but the load is supplied at a low power factor and the supply lines must be very heavy and relatively, expensive. This is quite a serious problem when welding the more difficult types of metals which demand short, single applications of large welding currents.

The ingenuity of welding engineers has led to the development of the stored-energy principle of welding, the energy being stored in either the electromagnetic or electrostatic form, in order to eliminate heavy instantaneous peak loads on the power supply system. The basic idea is to build up a reservoir of electrical energy, by placing a moderate demand on the supply line during the relatively long non-welding periods, and then tapping this power reservoir, as required, for the heavy instantaneous welding currents. The current thus delivered to the electrodes is free from disturbances originating in the supply line, because of other welding equipment. One method of accomplishing the stored-energy method of welding is to employ a bank of condensers as a power reservoir. By means of a three-phase rectifier, this condenser bank is charged at a high d-c. voltage. Then, by means of electronic control, the condenser energy is released to the primary of a special welding transformer. In other words, the welding current is delivered in "hammer-blow" fashion, rather than as a series of a-c. impulses. It is also possible to change the shape of the wave front by adjusting the condenser capacity and transformer ratio. There is thus opened a broad field of experimentation to develop wave forms best suited to meet various welding requirements.

One manufacturer experienced in the development of this equipment, reports highly satisfactory performance on welding jobs which require energy application for a period of less than 1/50th of a second. It has been found very satisfactory where the depth of weld must be controlled within narrow limits and is particularly applicable to welding thin pieces to larger sections. This new method is recommended for aluminum and magnesium alloys and is said to produce welds equal in quality, or even superior, to those produced by other methods.

It is reported that duralumin, one type of aluminum alloy, tends to disintegrate under welding temperatures, and thus loses some of its special properties acquired by heat treatment and mechanical working during the course of manufacture. One equipment manufacturer, using the electromagnetic stored energy principle and a variable-pressure cycle, manages to overcome these metallurgical difficulties. In other words, the employment of extremely short weld timing and precision control of welding energy, make it possible to meet the critical welding requirements of the aircraft industry. In the electromagnetic method of energy storage, the energy is accumulated during the non-welding period (less than a second). However, the energy discharge during welding may take place within 1/200th to 3/100ths of a second. At the same time, the variable-pressure control of the electrodes accomplishes a mechanical working of the metal which compensates for changes in grain structure caused by welding temperatures. The entire operation is automatic.

Many of America's largest aeroplane factories have chosen this as their standard equipment.

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Fig. 1—Example of downhand fillet weld, combining low cost with high quality.

Review of recent developments in

Pressure Vessel Welding

★ Comparison of regulatory codes — Present status of automatic versus hand welding — Three types of fillet welds.

By ROBERT LATTICE

EACH YEAR THE annual meeting of the American Welding Society stimulates thought on new and better methods of welded fabrication. In 1938 one of the most interesting of the new developments was in the field of automatic welding. Higher welding speeds along with a decided reduction in number of passes required to make a weld in heavy plate captured the fancy of every pressure vessel manufacturer present. After this development some felt that the acme of perfection in pressure vessel welding had been reached. But production men, by this time accustomed to lightning changes in the industry, had more startling developments in store for them.

Just as automatic welding captured the imagination at the Detroit meeting, so did flame plate-edge preparation at Chicago in 1939. This process bids fair to eliminate the large investments demanded for plate planers by offering faster production at lower cost. Flame-cut edges of the vee and double-vee types were no innovation. But U and J joints made with the oxygen cutting process had been unheard of. Add to this achievement, flame-deseaming to replace the slower and more costly pneumatic chipping and the full value of the new tool can be appraised.

Notwithstanding these important steps in the direction of more modern plant operation there remained one cloud, dark and ominous, on the pressure vessel horizon. The happy rumors of a combined pressure vessel code proved to be false. Manufacturers were obliged to work under both the ASME and the API-ASME codes in the fabrication of boilers, air receivers, liquefied petroleum storage tanks and refinery towers.

Perhaps the biggest point of controversy in the two codes develops

around the question of factor of safety. The more conservative ASME code requires a factor of five to one while the API-ASME code allows the designer a factor of four to one. The other points of difference in the two codes are more minor with the possible exception of test plates to qualify procedures, operators and vessels.

Qualification Procedure

In this respect the ASME code has done a commendable piece of work in adopting the qualification procedures of the American Welding Society. These rules are quite practical, because they lay full and proper emphasis on welding procedure, assuming that sound welds made under a qualified and supervised procedure must of necessity have the proper physical characteristics. Other than for those vessels that are manufactured under the provisions of paragraph U-68 of the ASME code, no test plates are needed to qualify the pressure vessel itself. On the other hand, the API-ASME code continues to require test plates for vessels (more properly for so many lineal feet of welding on seams) as well as to demand these plates for physical tests of welding operators.

In still another direction there is marked disagreement in the two regulatory codes. The API-ASME code allows the use of carbon steel and carbon steel alone for the construction of pressure vessels. This restraint limits the manufacturer to three steels: ASTM A-10, ASTM A-70 and ASTM A212. All of these steels are simple carbon steels with the ASTM A212 containing a very small percentage of silicon. Very definitely none of these steels would be considered as alloy steels.

Fortunately a more liberal attitude has been taken by the ASME code in approving low-alloy steels for special operating conditions. Not only have the low-alloy steels been adopted, but also have stainless steel and non-ferrous alloys found a rightful place under the ASME code. None of these materials were adopted without rigorous tests to determine their weldability and their suitability for pressure vessel service.

Automatic Welding

But enough of this discussion of the points of dissimilarity in the two pressure vessel construction codes. What are the newer developments? How are they being applied? It is with these things that we should concern ourselves.

Fig. 2 — Example of so-called stringer bead fillet weld.

Naturally in the forefront of newer procedures is the automatic welding process as applied to the seams both longitudinal and circumferential of pressure vessels. Three distinct processes are used to accomplish this welding. They involve the (1) carbon arc, (2) feeding of bare wire beneath a proper granulated flux (the so-called submerged arc process) and the (3) feeding of coated wire from a continuous reel.

Of all the modern automatic processes adapted to pressure vessel manufacture the carbon arc process is the oldest. It is limited in application to a maximum thickness of ¾ in. In this thickness range, moreover, this process continues to be the most economical of the three. A bare wire is fed into a carbon arc with the flux furnished either by a powder fed along the seam, or by a coated string fed into the carbon arc. Arc stability is guaranteed by a superimposed magnetic field.

The next process to be considered is the submerged arc process. Here a bare electrode is fed beneath a heavy blanket of flux to produce sound welds of great thickness in from one to two passes. The process is well fitted to pressure vessel fabrication with but a few exceptions. The long pool of molten metal obeys the laws of gravitation. Thus heavy walled vessels of small diameter are ruled out. This new process has found wide acceptance in pressure vessel work in spite of the few limitations.

Last of the three most widely adopted automatic welding processes is that which feeds coated electrodes (or winds a tape about a bare electrode). This process has for a selling point the elimination of electrode stubs and, at the same time, the stepping up of current values to permit faster welding. No limitations are placed on this process.

Auxiliary Equipment

All automatic processes must have suitable auxiliary equipment in the form of gantries and trunnions. Many satisfactory designs are available with the ultimate choice depending upon the user of the welding equipment. Capacity of trunnions and speeds of travel are all interlocked with the type of work to be done. In some cases the difference between success and failure may be a function of the design of travelling equipment to be linked with the automatic heads. As a general rule the control devices and welding heads are all that are furnished by the manufacturer of automatic welders. Engineering service is available to start the work and for consultation later.

Perhaps this discussion has led the reader to believe that the use of hand welding has almost disappeared from the pressure vessel shop. Such is not the case. Pres-

sure vessels have contributed their share to the increased consumption of coated electrodes each year. Some jobs do not warrant the set-up of an automatic unit. There are times when the machines are working at capacity. But most important are the many welds that cannot be made with automatic welders. These are fillet welds and welds around openings that are best made by hand.

Before considering the fillet welds, some attention must be given to trends in the hand welding of seams. There is no question that a multi-pass weld offers advantages over a single-pass weld. Remember this is a discussion of hand welding. Let's not bring in any argument about single-pass automatic welding. A few years ago welding engineers reasoned: A multi-pass weld offers some improvement in physical properties over a single-pass weld. Good. Now the idea is to see how many passes can be made in a weld. And by diligent effort, engineers found that they could make a weld in 1-in. plate with some 14 passes!

About that point in the proceedings the cost accountants began to make themselves heard. Because of the much greater amount of cleaning made necessary by the additional passes, costs were going sky high. Was the extra quality gained worth the extra cost? If stainless steel resists a certain corrosive action satisfactorily, no one suggests a silver liner. Then why pay for quality that is not needed? If an automatic process can make a good weld in one pass, why must a hand weld require fourteen? So reasoned the cost men. And they were right. Subsequently welding engineers developed procedures that completed a weld in one inch plate in 6 or 7 passes with good physical properties.

Electrode development accounted for much of this change. Turning from the "hot" rods with the ability to use very high current values, electrode designers brought forth electrodes that maintained high deposition rates without the need for exceptionally high currents. As a certain result, quality welds in fewer passes were the order of the day.

Fig. 4—Suitable scaffolding enables many welders to make vertical fillets at one time.

Three Types of Fillets

As the costs of welding attracted more and more consideration, fillet welds were given their share of attention. Three distinct types of fillet welds were attempted. The most successful was the positioned fillet weld which combined high weld quality with the lowest labor cost. This weld is illustrated in Fig. 1. Large diameter electrodes were used to make the larger welds. Still another type of fillet weld that enjoyed a brief popularity was that shown in Fig. 2 and known as the stringer bead fillet weld from the manner in which the beads were deposited. Costs were a bit lower than those reported for the oscillated type of fillet shown in Fig. 3. Appearances seemed to favor the latter type and present practice prefers the use of either the positioned fillet, or the oscillated fillet as a second choice where positioning is out of the question.

Along with the trend to fewer passes in seam welds there was a similar trend in fillet welding. Since the newer electrodes used less heat than the older types, there was made available more current in the power source to enable the operator

Fig. 3 — An out-of-position fillet weld illustrates the fine appearance which is characteristic of welds made by properly trained skilled operators.

Fig. 5—Operator is preparing a welding groove with the oxy-acetylene deseaming torch.

to use large electrodes. The change to electrodes of bigger diameter gave the welder wider grooves in which to manipulate his electrode with better weld cleanliness.

Higher-Strength Steels

So much for the electrodes and the manner and types of welding. Engineering requirements of certain service conditions demanded newer steels. Among these was the ASTM A212 type formerly known as ASTM A149 and ASTM A150. This steel possesses a tensile strength of either 65,000 psi, or 70,000 psi. minimum depending upon the grade selected. The greater strength allows the use of thinner shells where corrosion is not a factor. Extra material costs are more than offset by lowered fabrication costs. Too, truck tanks constructed under either of the codes offer a decided advantage from the standpoint of weight reduction. So this material has won a well deserved place on the designing boards of up-to-date fabricators.

Another application requiring the use of a special steel is for pressure vessels designed for operation at high temperatures. Here temperatures run from 850 deg. F. to 1000 deg. F. At these temperatures steel has a tendency to grow. Needless to say this growth destroys the usefulness of the vessel by reducing wall thickness and the design factor of safety. To combat the growth, or more properly "creep," that takes place at elevated temperatures molybdenum is added to steel. The extra initial cost of material is more than balanced by the saving in fabrication cost. When thicker vessels are under consideration, design advantages contribute to a substantial saving in overall cost.

Nickel for Impact Strength

Yet another important adaptation of a special steel is the use of nickel steels for low-temperature service. While all of the properties of steel appear to be enhanced by lower temperatures, one physical manifestation runs counter to the general trend. For the impact strength of ordinary steel suffers from the slightest lowering of temperature to or below the freezing point. A small percentage of nickel restores the much needed shock strength. Addition of nickel actually improves this strength to a point above that of standard carbon steels in the ordinary range of temperatures.

Other special service needs are met by the use of non-ferrous alloys in addition to the more widely-publicized stainless alloys included in the ferrous classification. In every case the choice and administration of a sound welding procedure results in good welds at reasonable cost. But adequate supervision is demanded along with the necessary amount of experimental work to precede the first job involving fabrication of a new material. So simple has welding become that some of us are tempted to throw caution to the winds, when embarking upon a new material. Here, again, the old maxim about "an ounce of prevention . . ." may be somewhat trite but just as true today as when it was first stated.

In addition to the many metals and alloys used for solid construction there are many special or composite materials enjoying wide application. Here the low cost and good strength of mild steel is combined with the higher cost and excellent corrosion resistance of alloys to make a composite vessel.

Two distinct types of liners are applied in pressure vessels by spot welding. The oldest method welds the lining material to the mild steel directly. A newer procedure welds the liner to the mild steel with an intermediate layer of another metal. Both lining methods are quite satisfactory in the many installations in which they have demonstrated the feasability of the combination. Generally Type 410 stainless steel modified to the exact needs of the vessel operator supplies ample resistance to corrosion.

The latest announcement in this direction is the melting of stainless alloys direct from a special electric furnace onto the surface of the mild steel slab. An alternate scheme involving some of the same principles melts ferrochrome on the surface of a slab by means of an automatic carbon arc. Both types of composite slab manufacture are claimed to be less expensive than applying a thin sheet of lining material. Time alone will prove the truth of their claims.

Plug Welded Liners

But some shops are not equipped to spot weld liners. Nor is the spot welding of liners to existing vessels very practical. Hence plug welding of various liner materials occupies an important place in pressure vessel construction. Among the alloys used are all of the different stainless steels, all of the nickel alloys in addition to pure nickel and the silicon bronzes. Furthermore copper and lead clad materials are either fabricated as clad sheets or as linings. So complex are some of the chemical processes that additional alloys other than those enumerated must be developed besides those already on the market. That's about the whole picture as regards materials in common use for pressure vessels.

Now for one of the more fascinating phases of pressure vessel manufacture. Since so much has been said about the theory of plate edge preparation and deseaming, perhaps that aspect of the subject should be disregarded. Instead, what about the practical application of the new tool?

Flame - Deseaming

SPEED (with capital letters) is the outstanding feature of flame-deseaming operations. The amount of skill needed to operate the torch for "land zone" removal is about the same as that required for weld-

ing. Considering the cost of raw materials (oxygen and acetylene) it is advisable to use a good operator for this work. At first oxygen will be drained out of the high-pressure manifold at an alarming rate. Later increased operator skill will drop the consumption figures down in line with the values reported by the designers of the tips and torches.

Although two reasons (high speed and low cost) should suffice for the deseaming operation, there is still another advantage. In heavy shells, and particularly in alloy steels, the amount of heat left in the groove eliminates an expensive preheating operation. Where fuel gas becomes an important factor, the deseaming process offers an added incentive.

Cuts Down Noise Level

Then there is a hidden bonus. Gradually the noise level of a shop using oxy-acetylene deseaming equipment is lowered. Then an appreciable lessening of nervous tension on the part of shop workers is noticed. Production costs in some instances have dropped sizeably because of noise reduction alone. One superintendent declared himself willing to use the gas torch for deseaming work even at a greater expense, because of speedier deliveries and less shop racket.

Thus I have tried to paint the picture of pressure vessel manufacture as currently conducted. Welding is an infant industry. That's the fun of being in it. And just as surely as new developments change the scene today, as they did yesterday, even newer achievements will be announced tomorrow. What new developments will headline the 1940 meeting at Cleveland?

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How Wearing Surfaces of Pug Mill Augers are Built Up

★ Several methods have been used to hard-face pug mill augers, depending on the material of which each auger is made. Cast steel augers, hard-faced with wear-resistant alloy, give excellent results. The hard-facing is applied readily with complete assurance that the auger will be in every way satisfactory after welding. Often, the hard-facing alloy is deposited on just the periphery of the flights; sometimes it is applied to the radial surfaces as well.

While it is not usually recommended that augers made of cast-iron, sometimes chilled, be hard-faced, since the welding heat affects the iron adversely, they can be protected effectively if fitted with steel wearing strips which are, in turn, hard-faced. The wearing strips are usually bolted to the periphery of the flights on cast-iron augers. In most instances, steel pug mill augers are rebuilt in the same manner as are conveyor screws—on the flight peripheral edges. Hard-facing alloy on the periphery assures that the auger will retain its full diameter and remain efficient.

Preparation of an auger for hard-facing consists in cleaning the peripheral edge of the flights with a grinding wheel, then preheating the auger to a dull red heat in a furnace. It can then be removed from the furnace and covered with asbestos paper during welding so that it will retain the heat. If conveniently possible, it should be placed so that it can be turned during welding to keep the area being surfaced approximately level. Haynes Stellite rod of the hardest grade (No. 1) can be applied to the full width of the flight edge through a hole in the paper which exposes a part of the area to be surfaced. The alloy is deposited on the steel surface, while the steel is just "sweating" under a carburizing flame. As the deposit progresses, the auger is turned and the paper moved to expose the surface being welded.

When the deposit is completed, the auger can be covered completely with the asbestos paper and allowed to cool. With a relatively smooth alloy deposit, no finishing is necessary. Figure 1 illustrates an auger hard-faced on the peripheral edge of the flights by this method. Approximately 3 lb. of hard-facing rod was used on this auger and the actual welding time was 2 hr.

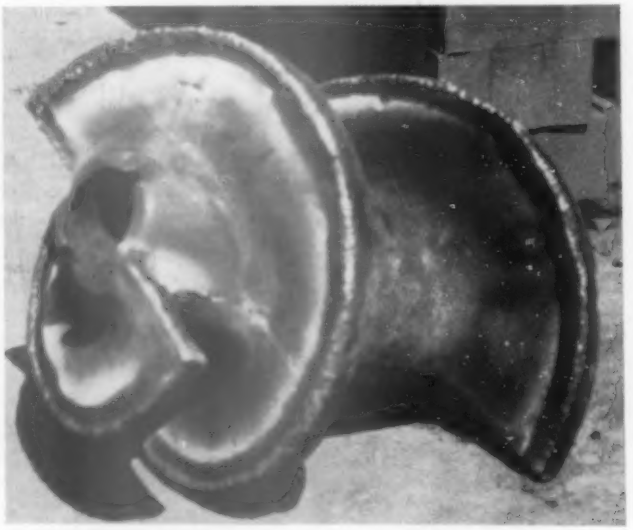

Fig. 1 — Hard-facing alloy is applied to the flight peripheral edges of a pug mill auger. Photo (Haynes Stellite Co.).

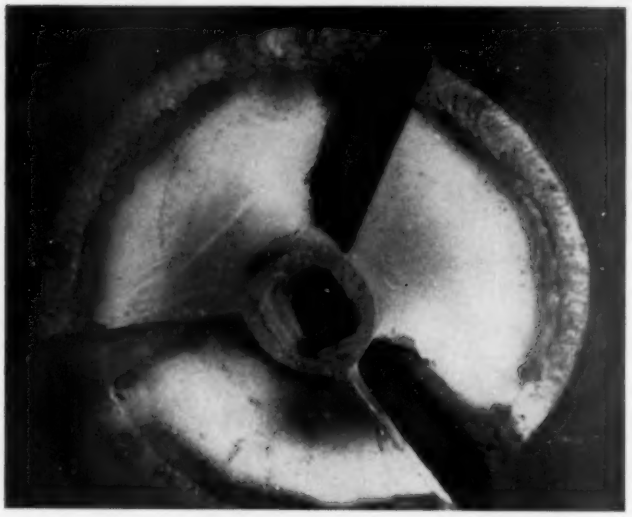

Fig. 2 — This pusher blade has been hard-faced on its periphery and face. Photo (Haynes Stellite Co.).

Fig. 3—Section of a pug mill uncovered, showing two of the three pusher blades and part of the auger. Photo (Haynes Stellite Co.).

Recently, one company has begun to hard-face auger flights on the leading radial surfaces as well as the peripheries, because it was found that the handling of certain clays wore the steel under the hard-facing deposit on the periphery. This company uses augers made up of three individual flights. As the back flight is worn most severely, wear is equalized by reversing the order of the flights, moving the back flight progressively forward one place about once every month.

When the face of the flight, as well as the edge, is to be hard-faced, the edge is done first and the flight face afterwards. Figure 2 illustrates a "pusher" blade for a pug mill auger, the face of which has been protected by Haynes Stellite alloy. The deposit is about ¾ to 1 in. wide and ⅛ in. thick. The augers are faced in the same manner. A mill with pusher blades and augers hard-faced on both the peripheries and faces is illustrated in Fig. 3.

The value of hard-facing pug mill augers is illustrated definitely by the experience of a western brick company. Total cost of hard-facing, including welding gases, rod, and labor, is $22. New augers for the machine cost $86, yet new augers last only 45 days, while hard-faced augers last 90 days. Thus, hard-facing, at about one-quarter of the cost of a new part, gives twice the life.

Longer Service Life

The experience of a pottery concern shows that unfaced augers used to last 18 to 24 working days. When augers are hard-faced on the flight peripheries only, their life is about 2 months, a life increase of approximately 3 to 1. When hard-faced on the peripheries and radial faces too, the life is increased to more than five months.

The pushers used in this company's mills do not wear out as fast as the augers. Before hard-facing, the pusher wore down 1 in. in diameter every month. A hard-faced pusher was still in service when last heard from after five and one half months. When wear on the diameter of the pusher exceeds 1 in., it is advisable to replace the blade. When hard-faced blades are partly worn, however, they can be rebuilt readily to their original efficiency.

Current Reviews

I.A.A. Technical Publications — The Oxy-Acetylene Committee of the **International Acetylene Association**, 30 E. 42nd St., New York City, has completed revision of three of its existing publications, namely Sections 5, 6 and 12, and the preparation of a new pamphlet, Section 13:

Section 5—"Sample Pipe Welding Specifications"

To meet the demand of architects and engineers for specifications covering the welding of piping to be incorporated in any general specifications. This pamphlet has been brought up to date—the guided bend test has been substituted for the present free bend test. Otherwise no changes have been made.

Section 6—"Tests for Selection of Welding Operators"

Intended for such purposes as the quick, economical selection of competent welding operators for other than so-called "code work." Need was found for some changes in wording to bring the text up to date and for clarification. The guided bend test has been substituted for the former free bend test.

Section 12—"Safe Practices for Installation and Operation of Oxy-Acetylene Welding and Cutting Equipment"

This pamphlet covers the storage of calcium carbide and gases, as well as the installation, operation and use of oxy-acetylene welding and cutting equipment. Chapters are devoted to eye protection, safe clothing, fire prevention, accident prevention and industrial health. This pamphlet has been considerably revised and enlarged. The chapter having to do with "Industrial Health" has been completely rewritten and brought up to date.

Section 13—"Flame-Hardening by the Oxy-Acetylene Process" (New Pamphlet)

This new pamphlet describes the nature and scope of flame-hardening, the hardness effects obtainable with the several types of steels and the technique used in hardening objects of various sizes and shapes. Contains approximate operating data for the more common flame-hardening operations.

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"Welding in the Aircraft Industry" is the subject of a paper by **L. P. Wood** in the July, 1940, issue of The Welding Journal. The paper is devoted principally to applications of the resistance welding process in the aircraft industry.

"Tentative Specifications for Iron and Steel Arc Welding Electrodes" is published in the July, 1940, issue of The Welding Journal. These are the new filler metal specifications drawn up jointly by A.W.S. and A.S.T.M.

"Resistance Welding of Aluminum and Its Alloys" forms the subject matter of the research supplement in the July, 1940, issue of the A.W.S. Journal. Material is a digest of the literature on the subject prepared by **W. Spraragen** and **G. E. Claussen.**

Fig. 1 — Combination of welded and bolted flanges in this pipe and valve assembly for a municipal power plant. Photo (Crane Co.).

Oxy-acetylene welding of

Carbon-Molybdenum Pipe

★ Advantages of this "creep-resistant" alloy pipe, as used with gas welding, presented from the fabricator's point of view.

By ERIC R. SEABLOOM

Research Engineer, Engineering and Research Division, Crane Co., Chicago, Ill.

IN PART I OF THE technical paper "Oxy-Acetylene Welding of Carbon-Molybdenum Pipe For High-Temperature, High-Pressure Service" by authors R. M. Rooke* and F. C. Saacke,* at the recent annual meeting of the International Acetylene Association, Milwaukee, Wis., the statement is made that carbon-molybdenum steel tends to crack readily, when under the customary degree of restraint obtained in a multi-pass weld. Thus it is stated that it may be necessary to preheat for several hours and employ as many as 70 passes on 1¼-in. thick material. This might lead the engineer, who is not thoroughly familiar with the characteristics of carbon-molybdenum steel, to believe that it is not readily weldable. We have conducted numerous investigations on the welding of molybdenum-bearing steels, including those with higher carbon contents than the present range encountered in tubing and have never found any evidence of check cracking, even when no preheat was employed. However, we are firm believers in preheating of alloy steels and always practice this

*Both men in the Apparatus Research and Development Dept., Air Reduction Sales Co., New York City.

Fig. 2—Close-up of welded piping shows how neatly the pipe welder can do his "stuff". Photo (Crane Co.).

Table 1—A.S.M.E. Boiler Code Working Stress Values

Temperature (F.)	—10 to 650	750	850	950	1000
Non-Killed Carbon Steel, Grade A	9400	8100	8100	2600	——
Silicon-Killed Carbon Steel, Grade B	9400	8600	6800	3800	2000
Temperature (F.)	—10 to 800		880	950	1000
Carbon Molybdenum Steel	11,000		10,500	8000	5000

procedure on pipe fabrications. Furthermore, we have never used 70 passes on 1¼-in. thick pipe. The maximum number employed several years ago was 26 on this thickness of pipe, when making vertical fixed position welds. More recently the number of passes has been somewhat reduced with the improvement in electrodes.

It might be well to emphasize that carbon-molybdenum steel was introduced several years ago, only after its properties, including weldability, had been fully explored by metallurgists and as a result has received wide acceptance attested by the fact that A. S. T. M. Specifications have been issued for both pipe and weldable grade castings such as employed for valves and fittings. The latest versions of the A. S. M. E. Power Boiler Code and the A. S. A. Pressure Piping Code permit the use of welded carbon-molybdenum pressure piping with much higher stresses at elevated temperatures than allowed with carbon steel.

Greater "Creep" Strength

The outstanding quality of carbon-molybdenum steel pipe is its greater creep strength at high operating temperatures. In the A. S. M. E. Power Boiler Code, maximum allowable working stresses have been adopted for ferrous materials based in the lower temperature ranges upon tensile strengths and safety factors, but at high temperatures upon creep data. Up to 650 deg. F. the carbon steels are permitted to be worked at one-fifth of their minimum specified tensile strength, while one-fifth of the tensile strength of carbon-molybdenum steel is allowed up to 800 deg. F. Above these limits maximum working stresses are based upon 80% of the creep stress, which limits deformation to 1% in 100,000 hours. Working stress values in psi., abstracted from the Boiler Code table of stresses for pipe are as follows:

A comparison of the stress values shows the advantage which has been gained through use of carbon-molybdenum steel in the design of pipe for operations at temperatures above 750 deg. F. Another advantage that carbon-molybdenum steel possesses over other high temperature steels alloyed with such elements as chromium, nickel, vanadium, tungsten, etc. is that it displays very moderate air-hardening properties, thus imparting good welding characteristics without much danger of cracking. This makes it unnecessary to stress relieve immediately after welding. In fact, the latest draft of the A. S. A. Pressure Piping Code only requires stress relief on ½ in. and heavier sections.

Most alloy steels that show air-hardening tendencies generally display suppressed transformations upon cooling from high temperatures and is the reason why certain steels are apt to crack when welded. Dilatometric studies of steels reveal some very interesting information on this subject. Figure 1 illustrates the Leitz optical dilatometer used in the Crane Research Laboratories for the study of heating and cooling effects upon metals, and is a very useful tool in determining proper heat treatments of steels. In this instrument the metal specimens are heated and cooled in a furnace, which is either under a vacuum or a controlled atmosphere so as to give freedom from scale and decarburization. The expansion and contraction that occurs upon heating and cooling are automatically recorded on a photographic film through the optical system.

Dilatometer Curves

Figure 2 shows heating and cooling curves on plain carbon, carbon-molybdenum and 4-6% chrome-½% molybdenum steels. It will be observed that upon heating, these steel expand according to a slope of approximately a straight line or a smooth curve. Then a point is reached at which they contract and continue to contract over a considerable range of temperatures. Beyond that range each steel again expands according to a slope of nearly a straight line. The temperature range in which the above mentioned contraction takes place is known as the transformation range. In it, on heating, steel changes from its low-temperature (ferritic) to high-temperature (austenitic) state.

Upon cooling, a reverse effect is obtained. In the case of the plain carbon steel, the transformation from the austenitic to ferritic state is well defined at the temperature range of 1400 to 1150 deg. F. In

Fig. 3—Optical dilatometer with automatic program controller. Photo (Crane Co.).

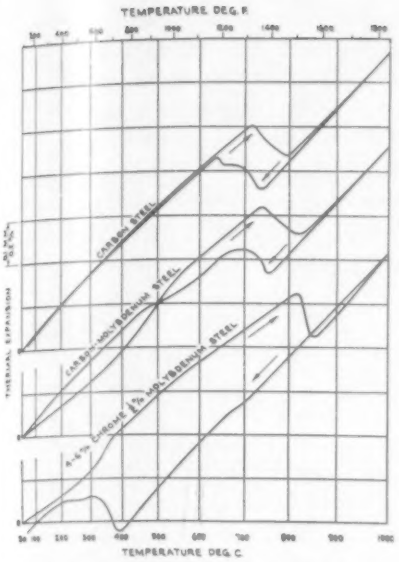
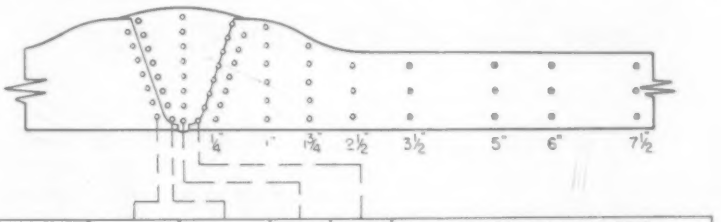


Fig. 4—Dilatometer curves obtained from (a) Carbon, (b) Carbon-Molybdenum, and (c) 4-6% Chrome, ½% Molybdenum steels. These show the expansion and contraction of the steel when carried through a definite thermal cycle.

carbon-molybdenum steel, the transformation on cooling is not quite as well defined as in carbon steel. The major part occurs at about the same temperature range as in the plain carbon steel. Part of it, however, is suppressed to about 980 deg. F., indicating what is known as the phenomenon of "split transformation." Nevertheless, in both of these steels, major contractions associated with the transformation upon cooling occur at temperatures sufficiently high to give the metal enough plasticity to readjust itself internally, thus relieving most of the internal strain and eliminating the potential danger of cracking. Consequently, no difficulty is encountered in welding steels of these two types.

In the case of 4-6% chrome, ½% molybdenum steel, only a very weak transformation occurs at 1250 deg. F. The major part is suppressed to about 700-400 deg. F. The split and suppressed transformations are characteristic of certain alloy steels and are accounted for by their thermal sluggishness. The important thing about suppressed transformations is that they occur at temperatures when the metal is no longer plastic, thus creating internal strains, which unless properly taken care of by suitable techniques may result in cracking. It will be noted that the presence of internal strain in the 4-6% chrome, ½% molybdenum steel is indicated by the fact that the specimen did not return to its original length, being somewhat shorter than it was before the heating-cooling cycle. It is natural to expect that steels of this type will show definite tendencies to crack during or after welding operations unless suitable precautions are taken. When proper procedures of preheating, welding, stress-relieving or heat treatment are followed, such steels can also be welded without difficulty.



CONDITION	⅛" OUTSIDE FUSION ZONE	⅛" INSIDE FUSION ZONE	CENTER LINE	FUSION ZONE	DISTANCE FROM FUSION ZONE							
					¼"	1"	1⅜"	2½"	3½"	5"	6"	7½"
AS WELDED	185	232	229	219	159	149	143	148	143	141	134	128
STRESS RELIEVED	152	176	178	161	142	133	134	138	138	133	128	122

14" O.D. TUBING UPSET FROM 1¼" TO 1⅜" NORMALIZED AFTER UPSETTING STRESS RELIEVING TEMPERATURE 1210° FAHR.

Fig. 5—Hardness survey of a weld in Carbon-Molybdenum steel tubing.

When the Air Reduction Sales Co. announced that they had developed a rod for oxy-acetylene welding that met the chemical and physical requirements of A. S. T. M. Specification A206-37T for carbon-molybdenum steel pipe, and also offered possibilities in increased rates of deposition, we were definitely interested. Fabricators and valve manufacturers are promoting carbon-molybdenum steel to a great extent. In fact, some valve manufacturers make it a regular practice to furnish valves in 300-lb. and higher pressure classes in carbon-molybdenum steel, because it makes it possible to gain increased temperature ratings for their product. Any welding process which shows potentialities in increased speed of deposition and cost reduction would naturally be beneficial to our industry.

We, therefore, arranged to conduct tests with this new rod and our preliminary investigations were made on 10⅝ in. O. D. by .718 in. wall thickness carbon-molybdenum steel tubing. The multi-pass backhand method was employed in making the oxy-acetylene weld. Four continuous circumferential passes were deposited in the downhand roll position, using 3/16 in. diameter rod. The welding torch was used for both pre-heating and depositing. The weld was completed in three hours time, after which it was stress relieved with the welding torch, by heating the

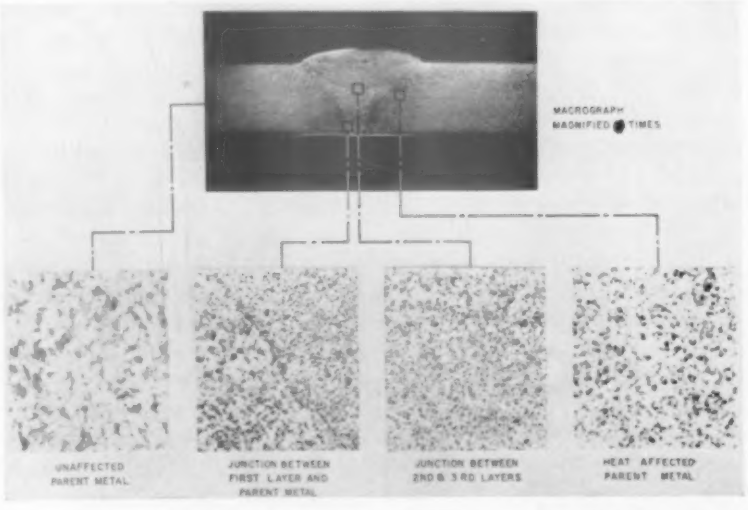

MACROGRAPH MAGNIFIED ● TIMES
UNAFFECTED PARENT METAL
JUNCTION BETWEEN FIRST LAYER AND PARENT METAL
JUNCTION BETWEEN 2ND & 3RD LAYERS
HEAT AFFECTED PARENT METAL

Fig. 6—Composite picture of grain structure of oxy-acetylene weld in "Carbon-Moly" steel tubing. Photo (Crane Co.).

weld and the adjacent metal to a medium cherry red color equivalent to approximately 1300 deg. F. Removal of the protective slag from weld metal is not involved in multi-layer gas welding.

Physical Test Results

Reduced section, tensile, nick-break, free-bend, root-bend, and side-bend bars were machined from the welded pipe and subjected to the regular tests. The physical properties of deposited weld metal exceeded those of the A. S. T. M. requirements as failures occurred in the parent metals of the tensile specimens. The free, back and side-bend bars were all bent 180 deg. without failure. The free-bend bars showed an average outer weld fiber elongation of 44%, which exceeds by a good margin the minimum requirements of 30%, stipulated by the latest draft of the A. S. A. Pressure Piping Code. The bend tests indicated that the weld metal was ductile and thoroughly fused to the side walls and bottom of the welding groove. The nick-break bars showed fine grain weld metal, free from injurious defects.

Impact tests conducted at room temperature compare favorably with the authors' results, the weld and heat-affected parent metals averaging 43.5 foot-pounds, Charpy.

Hardness Survey

A rectangular strip was milled from the pipe through the weld. This was machined, polished, and etched, after which it was explored for hardness on the Vickers hardness testing machine. The hardness values expressed in Brinell hardness numbers coincide with the findings of the authors and approximate those obtained on stress-relieved arc welds, as shown by Fig. 3.

Metallographic examination of the weld and adjacent parent material is illustrated by Fig. 4. The macrograph shows the weld metal, the coarser heat-affected adjacent metal, the heat-refined zone and coarser unaffected parent metal, the latter being somewhat larger grained than the heat-affected zone immediately adjacent to the weld. It will be observed that the multi-layer method of depositing the weld metal produced grain refinement in the lower passes, particularly in the first two. The photomicrographs illustrate the structures of the original material, weld metal and heat-affected zones.

A chemical analysis specimen was prepared in accordance with A. S. T. M. Specification A205-37T by depositing a pad of three superimposed layers of filler metal. The third layer was milled off and discarded, after which the millings comprising the second layer were analyzed for chemical composition. The analysis of the deposited metal, as well as that from several rods chosen at random, substantially compares with the authors' findings and corresponds to that required by A. S. T. M. Specification A206-37T for carbon-molybdenum alloy steel pipe.

We are now conducting additional tests on carbon-molybdenum oxy-acetylene welds in an endeavor to further substantiate these favorable indications. There is a distinct trend toward elimination of mechanical joints in piping installations, particularly for high temperatures where carbon-molybdenum steel is used. Fusion welding is the most logical solution to the objections that these joints present, as it eliminates weight, bulk, difficulties in stressing bolts, and joint leakage due to gaskets and creep of bolting. It is encouraging to fabricators and erectors of piping that an additional process has been made available for the welding of carbon-molybdenum steel.

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Welding Costs Can Be Reduced By Proper Assembly Dimensions

By E. W. P. SMITH*

THE DIMENSIONS OF the component parts of a product are important factors in meeting the requirements of the service in which the product is to be used. The finished product must have the strength, both mechanical and structural, required for the service and must have a form which will assure maximum utility, accessibility and simplicity for its user, and must be profitable from a manufacturing standpoint. Unless given adequate consideration, dimensions may spell the difference between efficient utilization of time, labor and materials and wasteful utilization. If size and weight fully meet service requirements, any increase would be wasteful and any decrease would impair strength.

The importance of dimensions of component parts lies in their cumulative effect. A slight error in the dimensions of one part may be so negligible as to have no appreciable effect on the product as a whole. Inaccuracies in dimensions of several parts will take on noticeable significance, affecting the product structurally or mechanically, for example, by increasing deadweight for no useful purpose, by contributing to an increase in total production costs by increasing the material, labor and time of manufacture.

Assembly dimensions are nowhere more important, nor more easily controlled, than in a welded product. Dimensions are the controlling factors in fit-up. Fit-up determines the amount of weld metal required in fabrication. Weld metal and, therefore, money will be wasted if assembly dimensions are such that more weld metal is required to make the joint than good procedure indicates is necessary.

Too often, the matter of fit-up of parts is regarded as something which the welding department insists upon to make its work easier by permitting greatest possible simplicity in assembly. There is no question that proper fit-up *does*

*Consulting Engineer, The Lincoln Electric Co., Cleveland, Ohio.

Fig. 1—(Left) How fit-up influences welding costs in a simple T joint of two ¼ in. plates.

Fig. 2—(Right) Costs are increased if vertical plate is 1/16 in. away from horizontal. In example, cited cost per foot of weld jumps from 38 to 60 cents.

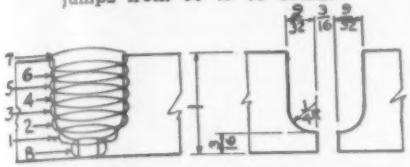

Fig. 3—In 1-in. butt joint, if root opening is 1/16 in. greater than necessary, 0.21 lb. additional weld metal will be required per foot of joint.

make the job easier! But it goes further than that. It makes the job more economical. It limits the amount of weld metal to just as much as, and no more than, the job requires. The effect of fit-up on welding costs is clearly shown by two simple examples.

In the first example, (see Fig. 1), a T joint is made in two ¼ in. plates at right angles to each other by a fillet weld in two beads. This joint would require .2-lb. of electrode per bead foot of weld or .4-lb. per foot of joint. On the basis of a deposition efficiency of 66%, the weld metal in the beads amounts to approximately .27-lb. per foot of joint. The cost per foot of joint is as follows; power at 2 cents per kwh., electrode at 6½c per lb. purchased and labor at $1. per hour, overhead 100% and operating factor 33⅓%:

Power	$\frac{190 \times 30 \times 2c \times 2}{.50 \times 35 \times 1.000}$	—	1.3 cents per ft. of joint
Electrode	.4 x 6.5	—	2.6 cents per ft. of joint
	Electrode & Power	—	3.9 cents per ft. of joint
Labor	100 x 2 x 2 / 33⅓% x 35	—	34.3 cents per ft. of joint
	Total Cost		38.2 cents per ft. of joint

At deposition efficiency of 66% there is .27 lb. of weld metal in each foot of joint and the cost is $1.41 per lb. of metal deposited in the joint.

If the vertical plate, instead of being against the horizontal plate, (as in Fig. 1), is 1/16-in. away, (see Fig. 2), and since the volume of weld metal in the joint increases with the square of the similar dimensions, the cost per foot would be:

$$\frac{38.2 \times (5/16)^2}{(1/4)} = 60 \text{ cents}$$

and for an opening of 3/32-in. it would be:

$$\frac{38.2 \times (11/32)^2}{(1/4)} = 72 \text{ cents}$$

while for an opening of 1/8-in. it would be:

$$\frac{38.2 \times (3/8)^2}{(1/4)} = 86 \text{ cents}$$

It is thus evident that it would be profitable to assure accurate fit-up of parts. As a matter of fact, it would be profitable to spend up to 22 cents, 34 cents and 48 cents (per foot) on preparation for fit-up to correct the 1/16-in., 3/32-in. and ⅛-in. variations respectively.

It should be remembered that the excess costs given (22, 34 and 48 cents) are for *deposited metal only* and proportionally figured. Actually the total costs would run 33⅓% to 50% higher, that is $2.00 to $2.50 or more per lb. deposited, due to greater difficulty in making a joint of poor fit-up. The figures therefore, are conservative.

A second example is a 1-inch butt joint as shown in Fig. 3. Made with proper fit-up, this joint costs a certain definite amount per foot. But if there is 1/16-in. greater separation than necessary, then .21-lb. more weld metal will be required per foot deposited. At $1.41 per pound, this would increase cost 30 cents per foot for each 1/16-in. additional separation above normal up to ⅛-in. or 3/16-in. For greater additional separations, the cost would increase tremendously.

It is evident from the foregoing that instead of being looked upon merely as a convenience for the welding department, proper fit-up through correct assembly dimensions, should receive the same careful attention from engineers and designers that they give to any phase of the product which affects costs and which is controllable in the design stage. The possible saving, (the 22 cents amounts to 58% increase in cost of the example covered), more than justifies the extra thought and care necessary.

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Construction

Europe's Biggest Welded Tanker Completed—Great interest was shown recently in the trials at Malmo, Sweden, of the new all-welded tanker "Braconda." This vessel is the first large oil-carrying European craft which can truthfully be described as all-welded.

Built at Kockmus' shipyard, she has a deadweight capacity of 15,500 tons, which, the designers claim, is some 300 to 400 tons greater than a ship of equal dimensions in which the hull is wholly riveted. She has a length of 534 ft. overall, with a breads of 63 ft., and a draft of 29 ft. 6 in. Other tankers similar to the "Braconda" are now being constructed in Sweden. The "Braconda" has a service speed of 14½ knots per hr.

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H. C. Price Co. of Bartlesville, Okla., has been awarded contracts for arc welding on the following pipe lines:

Illinois Pipe Line Co.—40 miles of 10-in. from Martinsville, Ill., to Brownstown, Ill.—General contractor Sheehan Pipe Line Construction Co.

Tuscarora Pipe Line Co.—30 miles of 8-in. near Allentown, Pa.—General contractor Superior Construction Co.

Buckeye Pipe Line Co.—55 miles of 10-in. from Cygnet, Ohio to Lima, Ohio—General contractor Sheehan Pipe Line Construction Co.

Michigan Gas Transmission Co.—60 miles of 24-in. near Zionsville, Ind.—General contractor T. R. Jones.

» «

Los Angeles Section A.W.S.—At the June 20th meeting, which was held on the Sky Deck of the Sky Room, Union Air Terminal, at Burbank, Calif., the subject of resistance welding as applied in aircraft fabrication was discussed by four able speakers. In addition, a motion picture film on resistance welding was exhibited through courtesy of Taylor-Winfield Corp. The program included "Electronic Control—Why Required" by **Edwin S. Dibble,** General Electric Co.; "Value of Research in Resistance Welding" by **Harry L. Chiles,** production resistance welding engineer, Lockheed Aircraft Corp.; "Development of Resistance Welding" by **Lorenzo Kennon,** mechanical engineer, Lockheed Aircraft Corp.; and "Sciaky System" by **Mario Sciaky,** chief engineer, Sciaky, Ltd., Chicago, Ill., and Paris, France. In addition to the technical program, Lockheed Aircraft Corp. presented a display of resistance welded joints as employed in present day aircraft fabrication.

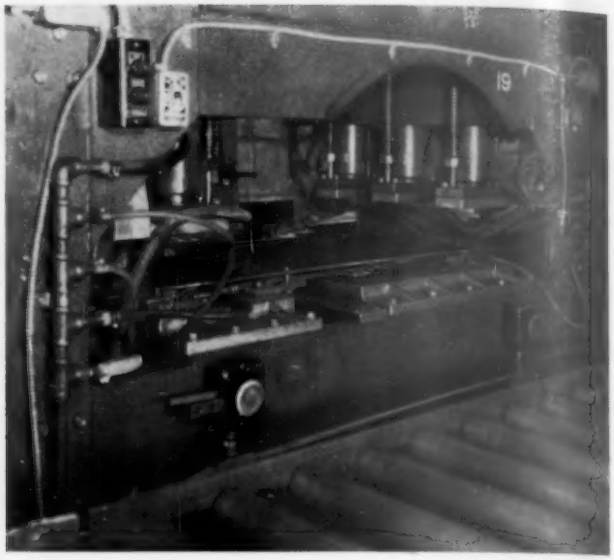


Fig. 9 — This machine welds supporting brackets on refrigerator condenser.

Application of

resistance welding to

Electric Refrigerator Units

★ Part 2 — How projection welding speeds production — How "pulsation" spot welding is done — Safety for machine operator is paramount consideration.

By E. R. SPITTLER*

Welding Engineer, Refrigerator Dept., General Electric Co., Schenectady, N. Y.

PROJECTION WELDING has received considerable attention from the standpoint of fast manufacturing methods, and an example of modified projection welding is shown in Fig. 9. Nine various shaped brackets are projection welded to a seam welded condenser. The welding of this condenser was described under Fig. 8. This operation is done on a welder rated 300 kva. It has two transformers, one rated 200 kva. and the other 100 kva.

Each transformer in this machine has thyratron control to provide interrupted current (several impulses for each weld). This method is known as "pulsation projection welding." A sample of the work done is illustrated in Fig. 9-A. The welding heads are hydraulically driven, and the welding sequence is shown in Fig. 9-A. There are seven welding heads and seven sets of electrodes on this machine. The first brackets are welded in one stroke of two heads simultaneously, following this operation; the second brackets are welded; then as a final machine operation brackets No. 3 are welded.

There are two operators running this machine and it can be loaded and unloaded from either side. It is of the electric solenoid-tripped type and there

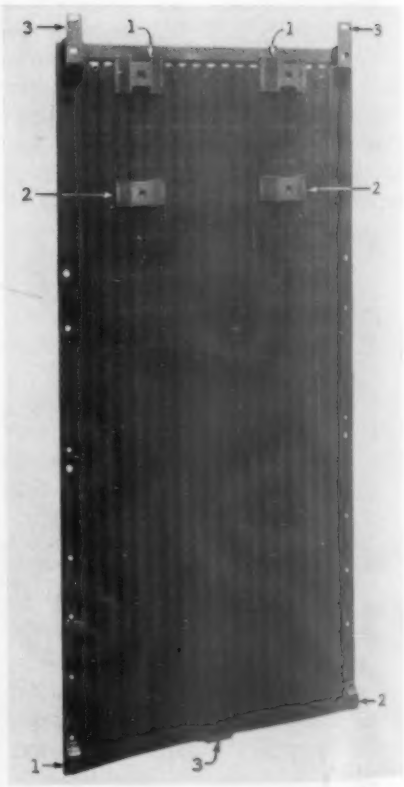


Fig. 9A—Supporting brackets welded on condenser.

*Part 1 was published in the June, 1940 issue, pages 17-19.

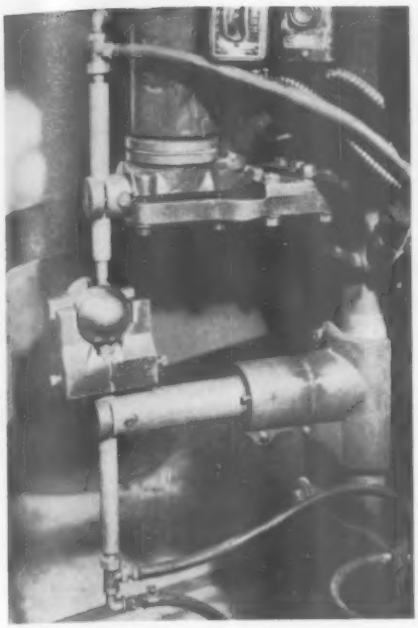


Fig. 10—Spot welding two halves of refrigerator float.

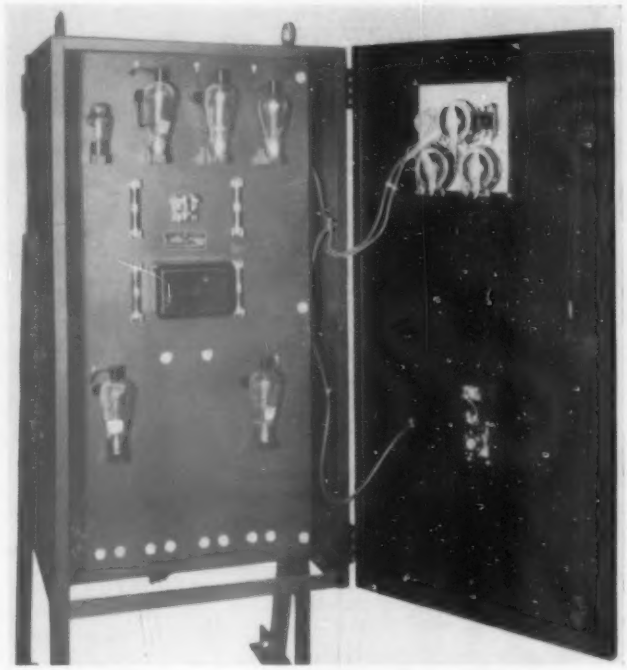


Fig. 12 — G.E. thyratron seam welding control. 220, 440 or 550 volts, 50/60 cycles.

are four push buttons wired in series, two on each side of the machine. The push buttons on each side are about 5 ft. apart, and it is essential that all four buttons be tripped simultaneously for the machine to operate, thereby eliminating the possibility of an accident. This illustrates one example of safety used on all welding machines in the General Electric refrigerator department.

Figure 10 illustrates pulsation spot welding of a float ball before entering a copper brazing furnace. This is done on a 20-kva. spot welder, and is thyratron controlled. The interesting part of this particular job is that the welding current is carried through the walls of this sphere. (Note the position for welding in Fig. 10). The stroke of the machine for making this weld is ¼ in., and the welding current is intermittent, applied for each weld with a duty cycle of four cycles on and four cycles off, repeated four times for each weld. This sphere is made of two halves and one overlaps the other. Each piece is .020 in. thick. To avoid excessive denting, low pressure (only 70 lbs.) on the chisel electrode is used.

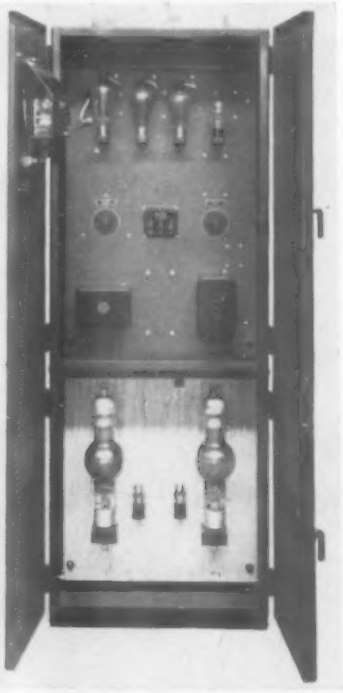


Fig. 11—G.E. thyratron line welder control panel with rectifier. Front view with doors open and tubes in place.

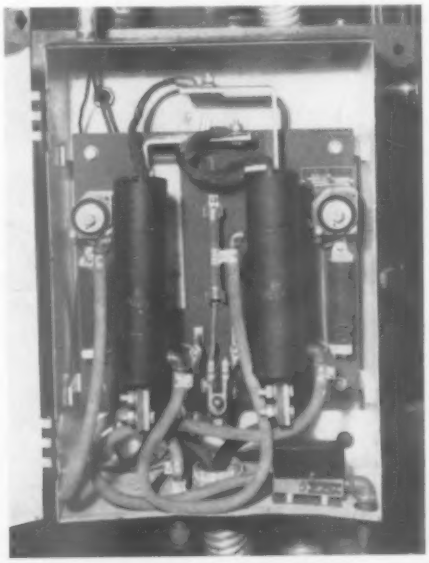


Fig. 13—Ignition contactor panel. This device makes and breaks the primary current to the welding machine.

All seam welding in the General Electric refrigerator department is thyratron controlled. Figure 11 illustrates the hot-cathode, series-transformer type control used for many years and a later design which does not require a series transformer (Fig. 12) but instead is equipped with water-cooled ignitron tubes made of metal. These new controls include phase-shift heat control. It has been found essential to use synchronous electronic seam welder control on all seam welders. A typical timing cycle used is 2 cycles "on" and 2 cycles "off" for 72 in. of weld per min. Without the off cycle it will be found that at speeds up to about 200 in. per min. the welding heat will travel ahead of the wheel electrodes, and these electrodes will

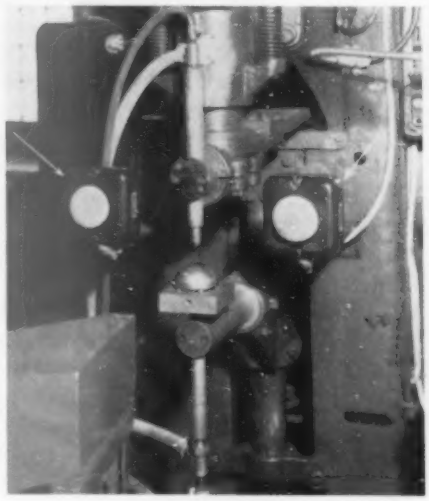


Fig. 14—Safety push buttons for tripping spot welder.

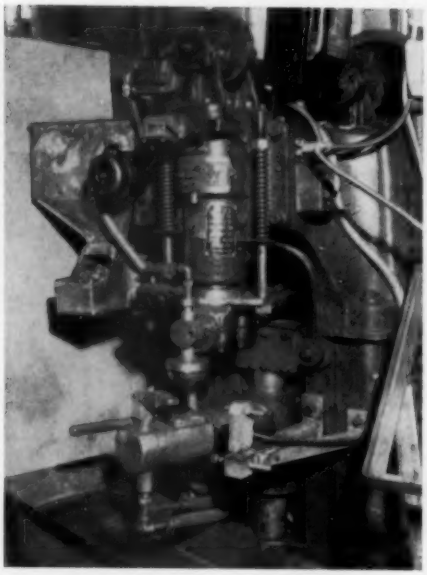


Fig. 14A—Swinging safety fixture on spot welder.

gradually sink through the surface of the material being welded, thereby producing a burned section in the material.

Figure 13 shows an ignitron contactor with water-cooled ignitron tube. This type control is used to replace the conventional type contactors.

There are no moving parts to carry the primary current load of a welding machine. Where spot or projection welders operate at high speed, the maintenance of a conventional type contactor becomes a costly item. This maintenance item and also non-productive shut downs for control repair are practically eliminated when the ignitron contactor is used.

Throughout high-speed production by the resistance welding method, the most important item is safety for the machine operator. In the General Electric refrigerator department constant supervision is striving to better the safety angle of welding machine operation. Figure 14 illustrates a safety precaution—two push-buttons are series connected, for initiating a projection welder. A swinging fixture is shown in Fig. 14-A. This fixture is loaded outside of the vertical stroke of the top head on the machine. The operator must swing it under the top head and hold it against a stop with one hand, while with the other hand he initiates the machine by pressing a push button. Various other safety features are employed, such as sliding fixtures. All this relieves the mind of a busy operator, assures safety, and results in a better grade of work and a smaller number of rejects.

New St. Francis Welded Siphon Moves a Million Gallons per Min.

★ The new siphon, which will carry water from St. Francis Lake over the levee into the St. Francis River near Marked Tree, Ark., and which is one of the largest in the world, was officially dedicated recently when Major Daniel Noce of the U. S. Engineer Office, Memphis, Tenn., turned it over to the Board of Poinsett No. 7 Levy District.

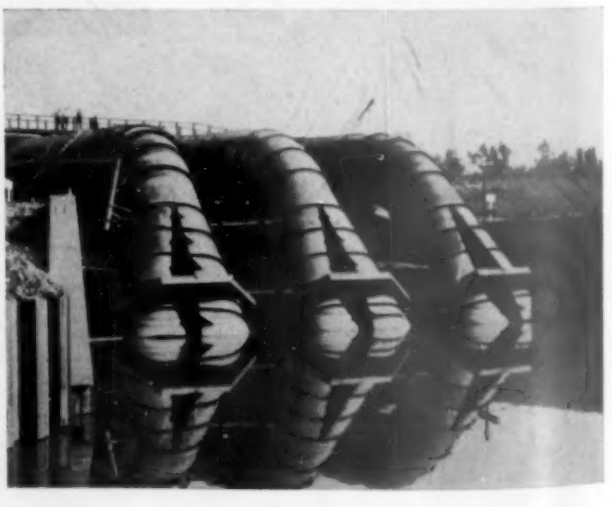
The purpose of the siphon is to maintain navigable depth of water at all times in the St. Francis River. Under all conditions except floods, it is necessary to take water from the St. Francis Lake and raise the river level to permit navigation. By construction of the siphon, it is now possible to transfer 2,600 cu. ft. of water per second from the lake to the river. Composed of three separate tubes, the St. Francis structure was constructed entirely by the arc welding process of joining pipe.

Each of the three tubes of the siphon is 9 ft. in diameter. The total length of the project is approximately 370 ft. The pipe wall is ⅜ in. thick. The ends are funneled outward furnishing an opening of 13 ft. diameter. At its highest point, which is 61 ft. 9-7/16 in. from the inlet side, the center point of the siphon is 27 ft. 4¾ in. above the lowermost point. The three tubes are 18 ft. center to center. The total length of the tubes, only, is 207 ft. 3-15/16 in. For a distance of 176 ft. 9¾ in. from the inlet side, the tubes lie in parallel straight lines. On the outlet side, the two outer tubes spread outward bringing the center line of the outlets 3 ft. 5½ in. outside the center line of the straight lengths.

The interesting feature of this structure is the fact that it was fabricated largely at the site. Pipe which was rolled during fabrication in 8-ft. sections, was welded in the field. A system utilizing discarded rails was employed upon which the sections of pipe were rolled during welding. The procedure was to take two 8-ft. sections, mount them together on the rolling fixture, line them up and weld them together by a continuous ⅜-in. 60-deg. bevel circumferential weld. Additional rigidity was provided the section by angle rings 5 in. x 3½ in. x ⅜ in. inside the pipe, placed in such a way that the joint came at the midpoint of one flange. This angle ring was welded to the inner surface of the pipe. Approximately 20,000 lbs. of shielded arc type electrodes were required for the welding. Arc welding equipment supplied by Lincoln Electric Co. of Cleveland, Ohio, was used.

Arc welded construction was also utilized in fabricating the sup-

(Continued on page 36)



Intake side of the St. Francis water siphon. Photo (Lincoln Electric Co.).

Fig. 1 — Pre-assembled side sections of a welded steel coal barge. Photo (Dravo Corp.).

Modern assembly plant for

Production Barge Welding

★ How Dravo Corp. uses streamlined production methods to build all-welded barges and towboats for inland waterways.

By GEORGE F. WOLFE
Chairman, Welding Committee, Engineering Works Division, Dravo Corp., Pittsburgh, Pa.

A DECADE AGO electric arc welding was generally conceded to be a rather fair means of doing emergency repair work. Then gradually, through indefatigable efforts on the part of arc welding equipment manufacturers and their sales forces, electric arc welding began to find a place in the fabricating and ship building industries. To reach this point it was necessary not only to expound the merits of the new process but to displace to a large extent the use of riveting, a process so old that its very origin has been clouded by the passing centuries.

During the period of development the manufacturers of welding equipment have shown a united front in a common cause with the result that their progress has been astonishingly rapid in the perfecting of welding machines and electrodes. The training of operators has been correspondingly active under the critical eye of the equipment manufacturers and their field representatives. But during all this time the users of the equipment have been left largely to their own individual resources to find economical means of production, which will justify their usage of the newer and admittedly better processes.

In some plants the change over to welding has been a gradual replacement of previous processes with but little alteration in the general methods of manufacturing. On the other hand, many industries and particularly such plants as structural fabricators and ship builders do not lend themselves to this transition without the sacrifice of economical operation.

The average first class structural or ship building plant is equipped with hundreds of thousands of dollars worth of tools which can be used only for riveted work. Fortunately such tools as shears, planers, bend brakes, bending rolls and press equipment are all adapted for fabrication in connection with welding but there is an even greater list which is not. Most of the punches, spacing tables, drills and riveting equipment with all its numerous accessories must sooner or later be discarded. Methods of handling based on many years of riveting experience must be abandoned. New equipment must be developed and new methods of fabrication and handling must keep pace with the welding operation itself to enable the manufacturer to

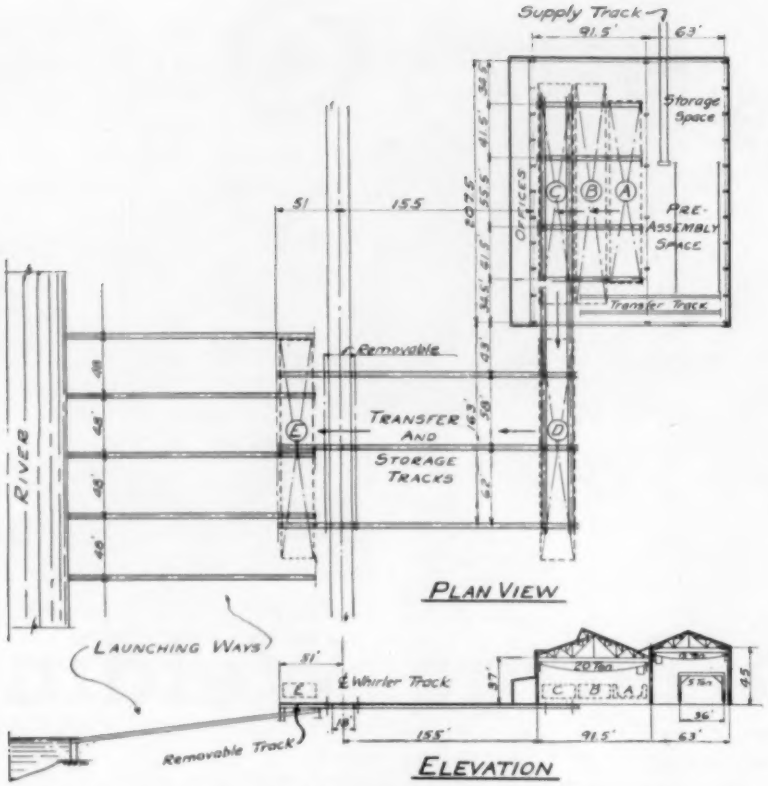


Fig. 2—Plan and elevation of barge assembly plant and launching ways at Neville Island, Pittsburgh, Pa.

produce the better product at an economical cost.

The not-so-far-distant scrapping of a large part of the riveting equipment will cause many a headache to the cost accountant who must be concerned with the depreciation and writing off of such once tangible assets which are rapidly becoming liabilities.

The larger fabricators and ship builders, with their present heavy burden of equipment mostly unsuited to welding, must compete for business with the small and, in many cases, new welding shops whose sole plant often consists of a light shed housing a small crane and one or more welding machines. This condition would indicate high profits for the small shop due to low overhead charges, but shops of this nature cannot meet mass production requirements, nor can they work economically until they make proper provision for positioning of work and handling of large assemblies into the finished structure.

The Engineering Works Division of the Dravo Corporation, located at Neville Island in the Ohio River ten miles below Pittsburgh, Pa., has been engaged in the building of floating equipment for a period of 25 years. The fabricating plant and launching ways on Neville Island were designed to accommodate riveted equipment, but the sudden transition to welded construction (starting in 1936) has caused many revisions in the plant.

The standard practice of ship construction on the inland rivers has been to erect a vessel in position directly over the launching ways and, after completing all yard assembly in this position, launch the ship sideways into the river. Heretofore the work has always been done outdoors and, in the case of welded vessels, is subject to more delays due to weather conditions and in general may require more time than does riveted construction. In busy periods, this adds to the congestion of equipment on the launching ways.

All the various parts of vessels are fabricated in the main Dravo structural shop and are then brought to the assembly plant in as large pieces as can be conveniently handled and received in the 63-ft. bay. Designs for the all-welded construction of vessels have progressed rapidly in the past few years and include the development of an improved all-welded coal barge, of which more than 100 have been built during the past two years. This barge lends itself particularly well to the assembly line method of production as the design was developed to permit large sub-assemblies. It is a barge of the hopper type, 175 ft. long by 26 ft. wide by 11 ft. deep. The sides consist of box sections about 3 ft. wide, 11 ft. deep and 30 ft. long, weighing about 8 tons each. Figure shows one of these side box sections as it leaves the structural shop. The side frames, which occur at about two foot intervals in these box sections, are pre-assembled and welded as one operation in jigs and are then assembled with the plating to form the box section. All overhead welding is eliminated by turning the box section over once during the welding operation. The interior of the box sections are painted by spraying before they enter into the final assembly. Five such sections form each side of the main body of the barge with similar box sections at the corners of the rake ends.

The bottom of the barge is framed transversely with special

Fig. 3—Shop assembled side section unit of welded coal barge.

Fig. 4—Special assembly fitting table designed for tacking serrated channels to bottom plates.

ports for each tube. Welded conserrated angle sections made by shearing channels into two symmetrical pieces, each half being approximately two-thirds the depth of the original channel, and welding these floor beam sections to flat bottom plates. A special fitting table, as shown in Fig. 4, was developed to automatically space and hold the serrated angle sections during the assembly and tacking operation. The flat plate is entered into the jig over a series of roller casters supported on a beam framework which is raised by hydraulic jacks. The serrated angle sections are entered into slots in the cross spacing beams prior to raising the bed by the jacks which clamp the entire assembly into position for tacking. The tacked assembly is taken from the fitting jig to tilting tables (Fig. 5) where the section is positioned at about 45 deg. and the serrated angles are welded to the plate by a continuous bead running entirely around that portion of the web that contacts the plate. After the welding is completed on one side of the connection, the table is tilted through an angle of 90 deg. for welding of the opposite bead.

The rake frames are assembled in the structural shop by jigging and corner section assemblies, similar to the side box sections, and are also pre-fabricated in large units before transfer to the barge assembly plant.

One of the chief benefits of the indoor assembly line method of production in the case of welded equipment is the ability to accurately schedule deliveries. The normal time cycle for erection of the standard 175 ft. coal barge described is ten days, and this time can be lessened by addition of extra shifts if desired. The operation is entirely independent of all weather and seasonable variations, which increases efficiency of the various labor operations.

Fig. 5 — Bottom plate and serrated channel assembly on tilting table for positioned welding.

All-Welded Towboat Hulls

In the building of all-welded hulls for towboats the barge assembly plant equipment has been used advantageously even when only one or two hull units are involved. A typical case was in the building of the hulls for two 350 hp., single-screw, diesel towboats where there was a decided advantage in building these full-formed hulls in an upside-down position to permit use of down-hand welding on the underwater portion of the hulls. The hulls were assembled in three 30 ft. sections in the barge assembly plant. After completion of all welding the three heavy sections were transferred on the hydraulic transfer carriages to the launching ways, where they were joined together into a complete structure. Consequently, the finished boat consists of an all-welded hull and superstructure with all welds, except the last two just mentioned performed under the most ideal conditions.

Fig. 6—Welded transfer trucks equipped with hydraulic lifting jacks.

Fig. 7—Finished barge in position on launching ways after transfer from hydraulic carriages.

The erection of the barge in the assembly plant is started by laying down the bottom plates with floor beams assembled and setting thereon the ten box sections comprising the sides. The supporting structure for blocking the barge during assembly, consists of permanent steel supports, at the proper level for convenient access for welding beneath the barge. The bottom plate sections, which come from the structural shop in 8 ft. by 25 ft. pieces, are pre-assembled in the side bay, into sections having a transverse width of 25 ft. and a length of 40 ft. by welding together five of the 8 ft. wide assemblies. Lap joints are used and the entire assembly is turned over in order to secure downhand welding throughout.

After the bottom plates and side box sections are in position all sections are brought into proper alignment, tack welded and the entire main body of the barge, weighing approximately 100 tons, is lifted from the blocking by means of hydraulically-operated jacking and transferring carriages located on the four transverse transfer tracks.

The transfer carriage, shown in Fig. 6, was given careful study before the final design was adopted as it represents the backbone of the entire handling operation. The all-welded framework is carried on four 18-in. diameter solid wheels, 4½ in. in width which were cut out of rolled steel billets. The two lifting beams of the carriage, to which the cushioned timbers are attached, are raised by means of four 15-ton hydraulic jacks actuated by oil under pressure produced by a hand pump. During the transfer of barges the change of direction of travel is secured by lowering the barge a few inches and supporting it on the permanent steel blocking and then continue the lowering of the lifting frame until it is about four inches in the clear below the barge. The entire carriage is then lifted by means of a roller bearing swivel hydraulic jack at the center of the carriage which engages a concrete pier at the intersection of the tracks. As soon as the carriage is lifted sufficiently so that the wheels are out of the track groove, the carriage is turned by hand through a 90 deg. horizontal angle and the change of direction is accomplished. The barge is again raised by means of the main lifting jacks and is now ready to be moved in a direction at right angles to its former line of motion.

The power for moving assembled barges from one position to the next is furnished by two single drum electric hoist engines acting through a wire rope system. One engine located at the extreme right side of position "A" serves for the transverse movement to positions "B" and "C", while the second engine located under position "B" serves to move the finished vessel out of the building from position "C" to position "D". A similar electric hoist is located at the head of the launching ways to move the barges from position "D" either into the storage space in the yard or directly to the launching ways.

After the main body of the barge is moved transversely to the adjoining position "B" the rake ends, which have been completely assembled in the 63 ft. bay, are brought over and attached to the main body of the barge and any loose plates necessary for complete closure are added. The major part of the final welding is done in this position, after which the barge is again moved transversely to posi-

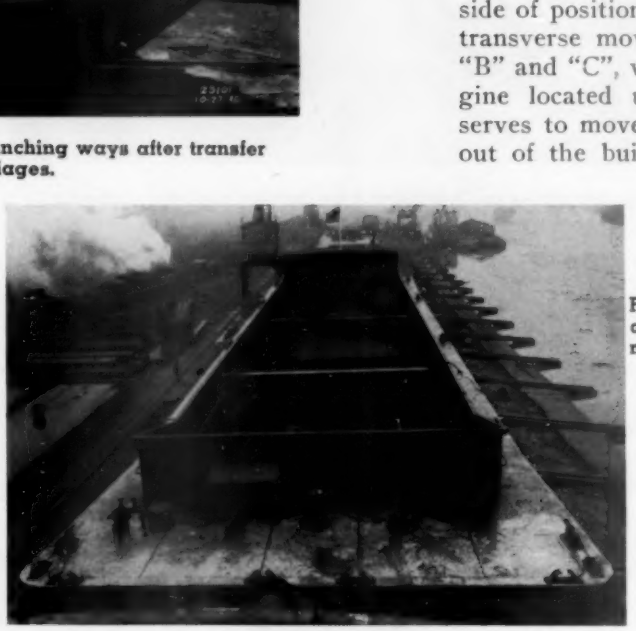


Fig. 8 — Welded steel coal barge built at Wilmington, Del. yard of Dravo Corp.

Fig. 9—Another welded coal barge recently built at Dravo's yard at Wilmington, Del.

tion "C", where any remaining welding is completed. The barge is now tested for watertightness by filling the various compartments with water after which all interior and exterior painting is completed.

The barge, which now weighs more than 150 tons, is raised on the transfer carriages and taken out through the end of the building, which is equipped with sliding doors to permit opening the entire width of the building, where the direction of movement is again changed to transverse and the vessel is then carried to position "E" (where the transfer tracks overlap the launching ways sufficiently to enable the transfer of the vessel from the hydraulic carriages to the regular launching skids). The vessel is then launched sideways into the river in the usual manner with the customary splash, and is ready for immediate service within 10 days after its start through the assembly line.

Wilmington, Del. Yard

Dravo also has an assembly yard at Wilmington, Del., connected by rail with the structural shop at Neville Island.* This gives the distant yard the benefit of the indoor fabrication facilities of the shop, where massive plate-forming equipment and work positioners conserve time and guarantee precision in welded assembly. A regular Dravo product is the standard type of coal barge. This is 134 ft. long, 34 ft. wide and 17 ft. deep. Bottoms, sides and ends are fabricated in sections at Neville Island, and these sections are shipped by rail to Wilmington, where they are assembled and launched. Thus, the major portion of the welding is done indoors, where there is no interruption of work due to unfavorable weather conditions, and where production line fabrication methods can be utilized to the fullest extent.

When it is a question of building hulls of special size and design, the procedure is the same and the economic advantages are comparable. For example, the coal barge shown in Fig. 3 is a special size: 170 ft. 1½ in. long; 40 ft. 1 in. wide; 17 ft. deep. In fact, this is reported to be the largest all-welded coal barge afloat. Its load capacity is 2750 tons. An unusual feature of the design is that the rake ends are a true radius; and tank tests have shown it to be more efficient than barges with standard or ordinary rakes.

The structural shop at Neville Island, in building this hull, fabricated: bottom sections 8 ft. wide by 40 ft. long; side sections 8 ft. wide by 17 ft. high; rake end sections 10 ft. wide by 20 ft. long. The design details in general are the same as those shown in Fig. 1 and 2, except for the difference in curvature of the rake ends.

At the Wilmington yard the order of assembly was (1) lay bottom plates; (2) erect side sections; (3) erect rake sections; (4) erect deck coaming and build the deck house.

In this orderly assembly procedure, the parts are accurately fabricated under favorable shop conditions. These sub-assemblies then flow together so rapidly on the ways that completion of a hull is a matter of days rather than weeks. The crane operator seems to pick up the pieces and put them together without effort, while the welding machines which accomplish the actual joining of the massive sections are so tiny in comparison with the job as to be scarcely noticeable.

*Remainder of article based on information from W. L. Humphreys of Wilson Welder and Metals Co., Inc.

Letters to the Editor

Is Welding So Simple?

Your editorial in the May issue is very interesting. There have been too many articles written lately on the simplicity of the welding operation. A continuation of such reading matter for the welding trade cannot help but have adverse effects on the industry.

The welding operators, men on the firing line who have invested years of work to obtain the skill they possess, do not believe that welding is simple. They have seen too many welds crack that were not sufficiently good to withstand the strains and stresses set up by the welding operation. The engineers also have learned that a carefully drawn up welding procedure has to be adopted and strictly adhered to in order to insure the acceptability of their welded products.

So, let us not think the job is too easy and get careless as we are bound to do if we believe there is nothing to the work in which we are engaged.

Welding is swiftly becoming the most important tool for fabrication purposes, but it is not a "cure-all," as there are still numerous applications where other processes can be and are used at a much lower cost figure.

We are all interested in building up the use of welding as a production tool, but it should be done on a sound basis. We cannot afford to belittle the efforts of the men doing the actual welding, as the electrodes (no matter how good they are) are only a means to an end, and if the work is not properly done, failures will naturally develop which would retard considerably the results we are so earnestly working to obtain.

G. L. Willins,
Welding Engineer, The Champion Rivet Co., Cleveland, Ohio.

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Trained Versus Untrained Operators?

You can't very well class me as a member of "the opposition" to which you appealed in your editorial in the May issue of *The Welding Engineer*, because my own interests are definitely linked up with the progress of the welding industry. There is nothing I would like better than to see the sale of arc welding equipment double or triple year after year. I feel, however, that Mr. Lincoln has gone just a bit too far in minimizing the importance of trained operators.

He is undoubtedly referring to large plants that have used welding for a long time and have highly developed procedure control, when he says, "The only thing that a welding operator can do is to hold the end of an electrode at a certain distance above the deposited metal and advance it along the seam to be welded at a certain speed. There

is nothing more than that involved in this operation. It is neither complicated nor difficult. As a matter of fact, with proper electrode, proper setting of the welding machine and proper preparation of the work, it is practically impossible to make a weld which will not stand up in service, without having it so evident to the inspector that he will immediately reject it."

It seems to me that airplane manufacturers might just as logically advertise that, "The only thing that a pilot can do is to move the stick, push the rudder bar and give the engine the gun. There is nothing more than that involved in this operation. It is neither complicated nor difficult. As a matter of fact, with proper gasoline, proper manipulation of the controls, and fair weather, it is practically impossible to arrive at the wrong destination without having it so evident that the pilot can return to his starting point and try again."

Responsible for distribution of a well-known line of arc welding equipment, I've been travelling about 30,000 miles annually for several years throughout the United States, Canada and Mexico, in order to get first-hand information. Naturally, this job has brought me into personal contact with large and small users of arc welding in various industries and I do not believe a large percentage of them would be any more interested in trusting their welding to inexperienced or untrained operators than in starting a flight across an ocean with an untrained pilot.

True, there have been remarkable developments and improvements during recent years with respects to equipment, methods and materials involved in arc welding. The process has unquestionably been greatly simplified, but I do not believe this condition should be exaggerated—that anyone should be induced to adopt the process believing that it can be effectively and economically used by inexperienced or untrained personnel. Such a policy could hardly be expected to contribute to the well being of the industry as a whole, even if it were acceptable in certain exceptional cases.

Contact with large users and with American Welding Society sections has given me the impression that there is more and more attention being paid to qualification of operators as well as of methods and materials. Welding schools all over the country are now crowded with men learning to weld. Vocational schools are showing more and more interest in teaching arc welding. That would not be true if those men did not sense an immediate or future demand for trained operators. In fact, many of us can remember the time when lack of proficient operators was one of the important elements of sales resistance encountered by manufacturers of welding equipment.

It seems to me that it would be better for all concerned to admit that best results from arc welding call for its use by skilled operators who know something more about what they are doing and trying to accomplish than the mere mechanical manipulation of the welding arc. In the textbook used at our factory-operated, non-profit welding school we say:

"Anyone with average intelligence, a steady hand, and a real desire to perfect himself in the art can readily learn to weld with the electric arc. To become an expert operator, however, requires something more than mere ability to manipulate the welding arc."

Continuing the quotation from our textbook: "The man who has had previous training and experience in some mechanical trade will develop more quickly into a proficient welding operator than the man without such training or experience. An experienced gas welder will find it extremely easy to become proficient with the arc due to his knowledge of metals, welding heats, etc."

In other words, while admitting the desirability of using trained operators, we try to point out the fact that it is not difficult to develop them, if none are available to the employer planning to adopt arc welding. Even where procedure control is so far advanced that little is left to the discretion of the welding operator, I personally believe that better welding may be expected when the operator knows "what it is all about."

W. J. Chaffee,
Welder Division, The Hobart Bros. Co., Troy, Ohio.

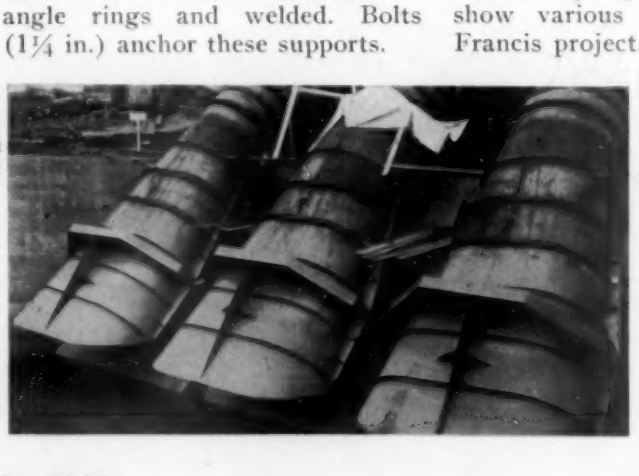
St. Francis Welded Water Siphon

(*Continued from page 30*)

ports for each tube. Welded construction was called for in the specifications. The supports consist of sections of angles 6 in. x 4 in. x ⅜ in. rolled to the radius of the pipe, butted together at the heel and arc welded to the pipe; also, bases fabricated from ½-in. plate into box sections upon which the holding ring is carried. Web plate stiffeners are notched around the angle rings and welded. Bolts (1¼ in.) anchor these supports.

Man-holes, having 8-in. diameter openings, are located at both the intake and discharge sides of each tube. These were also fabricated by arc welding. A steel bar 2 in. x 1¼ in. was welded to a plate which formed the cover. This cover, in turn, was bolted to the pipe by ½-in. hexagonal bolts 3 in. center to center. The gaskets are of rubber ⅛ in. thick.

Accompanying illustrations show various views of the St. Francis project.



Discharge end of the St. Francis siphon. Photo (Lincoln Electric Co.)

New Product Developments

These safety goggles give complete comfort and all-around protection.

Safety Goggles

★ NFA and NASO safety goggles can now be obtained direct from the manufacturer, **American Optical Co.**, Southbridge, Mass. Previously, these goggles were manufactured exclusively for the National Founders Association to be sold to members and customers as part of the association's service. However, the association has discontinued this practice, and has notified its members that orders should be placed direct with the optical concern.

These goggles are made in 50 and 45.8 mm. sizes and provide complete comfort plus all-around protection. They are equipped with pliable, snug-fitting leather masks, wire-screen ventilators around the eyecups, adjustable headbands, and can be supplied with Super Armorplate lenses (for protection against impact) or Calobar Super Armorplate lenses (for glare and impact).

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1940 Model Thomson No. 1 Welding Press

★ The new 1940 Model No. 1 Press not only retains all the best features of previous Thomson models, but embodies many new and important features that contribute greatly to its efficiency, adaptability, productivity, and operating economy. Of paramount importance to a manufacturer investing in press welding equipment is the adaptability of this new Thomson welding press. Not only does the interchangeability of the essential parts result in important reductions in original construction cost, but it is also possible at any time to remodel the machine to suit new requirements with a minimum of labor and expense.

For example, the machine originally purchased with a standard spring pressure head, can be quickly converted to an air lock head type, or a machine with an apron mounted lower arm can be readily changed to a column mounted type or to a knee type machine for projection welding.

Following are some of the important features of the Thomson 1940 Model No. 1 Press Welder:

The rigid, fabricated steel frame is substantially reinforced with ribs and corner struts to minimize deflections under the maximum loads prescribed by the R.W.M.A. The transformer is completely enclosed and protected.

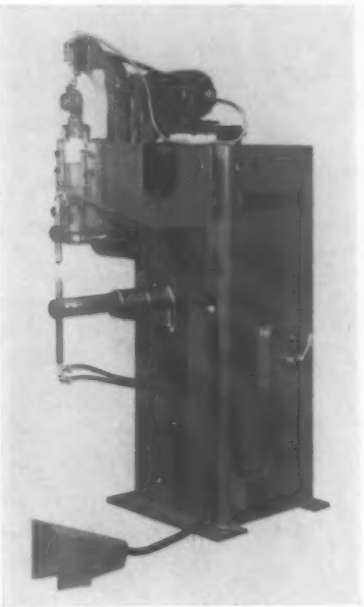


Fig. 1—Standard Thomson machine with spring head and lower arm socket bolted to apron.

The flat sliding head moves with straight-line action in adjustable gibbed ways. Peel-off shims provide adjustment for wear. Any looseness which may eventually develop can be quickly and easily taken up and the correct, smooth, free action in the slides maintained at all times. This feature greatly reduces maintenance costs. The sliding head unit weighs only approximately 33 lbs. and results in low inertia and quick electrode follow-up.

The sliding head is actuated by a special cam designed to slow down the electrode as it approaches the work and minimize electrode hammering. This cam action is preferable to a toggle mechanism, not only because it involves fewer moving parts, but because electrode contact is less severe than with a toggle, which, when properly set, must be a few degrees off center to provide for electrode follow-up. The head is returned by two compression springs which are concealed inside the neck.

A combination worm reduction and clutch unit running in an oil bath is an important feature of the 1940 Model No. 1 Press. Both worm and worm gear shaft are hardened and mounted on roller bearings to insure long life and low operating cost. The worm gear is bronze. A multi-tooth clutch mounted on the worm gear shaft is positive and instantaneous in action.

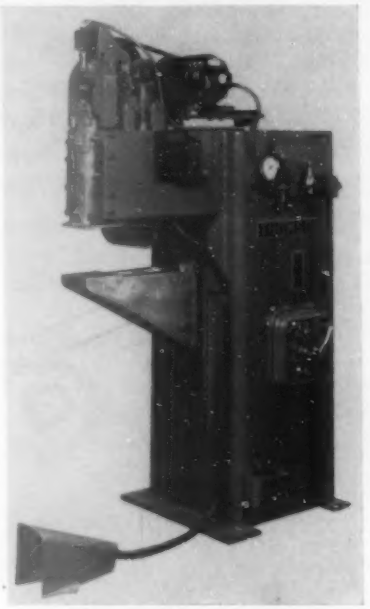


Fig. 2—Machine with air-locked head, lower knee and flat upper terminal pad.

Standard equipment includes a practical, reliable, precision-type limit switch for initiating the current flow. The limit switch is closed and opened by accurately adjustable multi-leaf fan cams which can be used to time the welds directly through a contactor, or through an auxiliary timing device such as a Thyratron or Ignitron or other timing unit.

A variable-speed pulley driven by a ½ h.p. motor provides infinite speed selection between standard ranges of 36 to 109 or 44 to 133 strokes per min. In keeping with R.W.M.A. standards, this new press is designed to operate at electrode pressures up to 1000 lbs.

Interchangeability and adaptability are additional features of this new welding press. As an example, the welding head is designed so that the same major parts are used to provide a choice of:

1. Adjustable spring pressure.
2. Adjustable air-lock pressure.
3. Straight air pressure.

Quick change-over can be made at any time with very little labor and few extra parts, it is stated.

The No. 1 Press is regularly equipped with the new, patented Thomson tubular secondary water-cooled transformer. Secondary sections of this efficient transformer are flattened, heavy-walled copper tubing in which maximum copper surface is exposed to the cooling water.

An effective thermal relay switch, connected in the contactor control circuit, provides complete protection against cooling water supply failure. The transformer ratings in accordance with R.W.M.A. standards are 30, 40, 50 and 75 kva.

For further information write to **Thomson-Gibb Electric Welding Co.**, Lynn, Mass.

» «

Whirlwind Wire Wheel Brushes

★ **Van Dorn Electric Tools,** Towson, Md., is now offering a new group of high quality wire wheel brushes which are being made by a patented process. These brushes, known as Whirlwind wire wheel brushes, are claimed to be outstanding for their quality and long life, both of which are apparent in the extra density of wire for any given width of brush.

They are available in sizes, thickness and wire gages to suit practically any wire brushing application—coarse wire which is ideal for cleaning castings, removing scale, paint and rust, etc.; and fine wire which is best adapted to work on aluminum, brass, molds, auto body work, buffing and finishing.

» «

D-C. Arc Welder for Mine Service

★ **General Electric Co.** has announced a new resistor-type, d-c. arc welder designed particularly for mine service. Portability and sturdy construction are among the chief features of this new welder. It is only 17 in. high, 20 in. wide, and 30 in. long, and weighs but 78 lbs. To withstand rough handling successfully, the resistor units are wound in continuous coils without joints and are supported by spool-type porcelain insulators. Enclosing screens protect the interior from falling material. Welding current can be adjusted over the welding range, in 10 steps of approximately 17 amp. each, by means of five heavy knife switches. It is nominally rated at 250 volts, and will operate on a power line of 225 to 275 volts.

The WD-150, while small in size, has a current range from 15 to 200 amp.

Small Welder Has Range Of 15 to 200 Amperes

★ A new welder, the P&H-Hansen WD-150, recently placed on the market by the **Harnischfeger Corp.** of Milwaukee, Wis., measures less than 33 in. in length and one foot in height, but delivers uniform welding currents ranging from 200 down to as low as 15 amp.

Current selection is simplified by a single control on the WD-150. Once the current setting has been made, the generator automatically responds with the desired arc voltage under all welding conditions. Non-synchronization of open-circuit and arc voltage is impossible because of the automatic volt-ampere regulation, self-excitation, and internal current stabilization of this machine.

A notable departure from conventional welder construction is the square frame design of the WD-150. Among the many advantages of this design, are two outstanding features. First, it permits an over-all compactness which in turn means more machine in less space and convenient stacking of the units. Secondly, the square frame design permits a better arrangement of coils, etc., which in turn provide better magnetic balance and greater cooling areas of the coils. With greater coil surface exposed to the air circulating screens, the internal temperature is substantially lower, thereby assuring longer life and a more uniform flow of current. The P&H-Hansen WD-150 square frame arc welder is available with stationary or portable mountings.

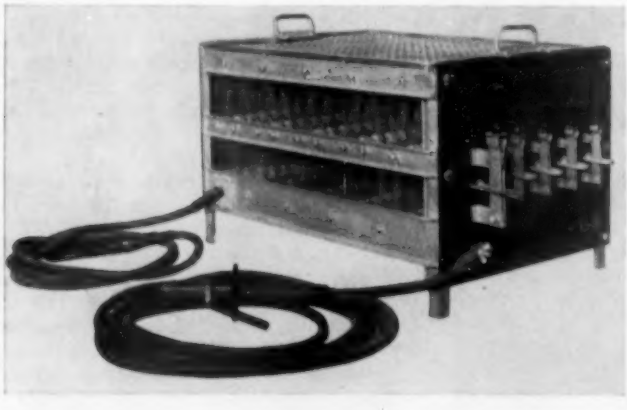
Welding Shop on Wheels For Heavy-Duty Spot Welding

★ A two-gun portable spot welding unit designed to eliminate necessity for duplicate welding equipment and for heavy-duty welding requiring high point pressures, large capacity transformer and adjustable weld time control for accurate timing has been announced by **Progressive Welder Co.**, 3033 East Outer Drive, Detroit, Mich.

Equipped with floor-saving pneumatic tires for easy portability, the new unit can be wheeled from one assembly location to the next as needed. A low production truck body shop, where an entire assembly is completed at one location, is one example of the versatility of this unit. In this type of work, the unit usually serves a group of welding fixtures used for sub-assemblies as well as occasional assembly line "pinch-hitting". Thus, welding equipment used only for peak rush is entirely eliminated.

Setting up for welding in a new location is a matter of minutes, since the only connections to be made are the air lines (for air-hydraulic pressure booster) water lines (for cooling welding cables, points and transformer) and the power lines.

The unit illustrated consists of two spot welding guns, transformer, air-hydraulic pressure booster, weld timer and contactor. Both the push gun (supplied with grounding clamp) and scissors type gun operate from the single transformer mounted in the base of the carriage. Welding point pressures up to 1,000 lbs. (for the scissors type gun) are supplied by the booster mounted above the transformer and operating from the standard factory air pressure line. Pro-



G-E mine type resistor arc welder, 225 amp., with 25-volt arc at 250 volts open circuit. Includes trolley hook and cable.

To eliminate necessity of duplicate, peak-rush welding equipment, Progressive Welder offers this portable two-gun heavy-duty spot welding rig as a "complete welding shop on wheels".

vision is made to water cool gun jaws and points through individual supply and return lines. Transformer is also water cooled.

When the unit is to be used for more than one type of welding, a special weld timer having two separate control dials permits adjustment for two separate weld times for each gun. In this case, each gun is supplied with two control buttons, the operator using the proper button for the work to be welded. With this type o ftimer, two operators can use both guns simultaneously on different types of work.

A wide range of spot welding of heavier type can be handled by the new unit which is a companion model to a smaller capacity single gun unit manufactured by the company and recommended for fabrication of lighter sheet metal.

» «

Tube-Turns Welding Tee

★ A new line of seamless steel welding tees having several distinctive advantages has recently been developed by **Tube-Turns, Inc.** of Louisville, Ky. The important feature of this new tee is that full pipe strength is attained through proper placing of metal at points of high stress, rather than by excess thickness throughout and consequent useless weight.

Stresses due to internal pressure are highly concentrated at the intersection of the outlet with the run of a tee. While not a great deal is known as to the extent and exact location of the maximum stresses existing in the tee, it is generally believed that the greatest stress occurs at the crotch and that it may be, when unreinforced, as much as twice that in straight pipe of the same size under the same pressure.

The new Tube-Turn tee design meets this condition adequately by providing substantially more metal thickness at the crotch. The thickness from this point, that is along the top centerline of the run of the tee, is gradually reduced to nominal at the bottom of the tee where stresses, when reinforcement at more highly stressed points is ample, again reach normal.

Another important improvement is that longer outlets are provided for greater ease in lining up and welding.

New Tube-Turn reinforced tee design.

The new Tube-Turn tees are accurately machined, scale-free and stress-relieved.

A new 64-page catalog and data book describing this tee and giving complete information on practically all types of welding fittings and forged steel flanges is available upon request and may be had by addressing the manufacturer, **Tube-Turns, Inc.,** at 255 East Broadway, Louisville, Ky.

» «

New Wheel For Grinding Welds, Snagging Castings

★ Atlantic Abrasive Corp., 540 Pearl St., South Braintree, Mass., has introduced a new type of wheel, especially designed for weld grinding and snagging. This wheel, designated as Atlantic Type AK, makes use of a patented synthetic bonding material to permit maximum working speed and pressure without danger of burning. Use of this wheel will lower labor costs and produce a better finished product, according to the manufacturer. Further details on this new wheel and other special grinding wheels for steel, alloys, plastics and rubber will be sent on request.

» «

Wonder-Weld heat-insulating compound.

"Wonder-Weld" Heat-Resisting Compound for Welders

★ A new product which can be employed for the purpose of concentrating heat to any desired spot in a metal surface, has been developed by **Miller Mfg. Co.,** 1220 Kaighn Ave., N. Y. This patented compound should interest welders and repairmen, particularly in automobile body and fender shops. It is intended for use where the oxy-acetylene torch is to be used in welding or brazing or soldering any part near rubber, wood, upholstery, paint, etc. It is said to possess good heat-resisting qualities and to be harmless to any surface on which it is applied. It is additionally claimed that "Wonder-Weld" heat-resisting compound is able to withstand a direct heat application such as from a welding torch, without disintegrating. Purpose of the compound is to localize radiation of heat and protect painted or enemeled surfaces from damage by the welding torch. It will also protect thin sections from buckling and will prevent low-temperature alloys such as soldered joints, from melting. It is claimed that it will prevent loss of hardness in tempered metals.

In using the compound, it is mixed with water to a paste consistency and then spread over the area to be protected, by applying a thickness ½ to ¾ in. Enough area should be covered to prevent the torch flame from over-reaching the protected area. By this means the heat will tend to remain concentrated in the desired spot.

» «

This bending press has welded frame.

New Steelweld Bending Press

★ The **Steelweld Machinery Division** of the **Cleveland Crane & Engineering Co.,** Wickliffe, Ohio, has developed a series of Steelweld bending presses adaptable for extension of bed and ram at one or both ends. Illustrated is a Steelweld Model H-8 recently completed for a foreign customer. This press is provided with extensions of 2 ft. on each end and normally handles plate 8 ft. x ⅜ in. between housings, but the extensions make possible the forming of plate 14 ft. x No. 12 gauge. Other Steelweld presses developed in this series will handle plate in lengths up to 20 ft. and thicknesses up to ¾ in.

The frames for these machines are of one-piece all-welded construction and will remain rigid for life. All gearing is protected in metal enclosing covers. Shafting and machinery are located at rear of the machine, thus preventing damage from bent-up plates, crane hooks, etc.

Two solid forged steel eccentrics, one on each end of the machine, operate the ram. Each eccentric has three extra large main bearings and an eccentric bearing. These bearings are automatically lubricated by two pressure-type oiling units mounted on either end of the machine. The main drive clutch is of the heavy multiple-disc type and is easily adjusted without tools. Usual brake troubles are eliminated by using a clutch, which is a duplicate of the main clutch, for braking.

News of the Industry

Scope of The Engineering Foundation—Seventy-three research projects involving an aggregate of $3,111,374 have been carried out by The Engineering Foundation since it was established in 1914. Notable contributions have been made to science, engineering, industry, and the humanities during a 25-yr. period characterized by profound change, says a report made public by Dr. Otis E. Hovey, director of the Foundation.

"Researches have been assisted by funds appropriated from the income of the investments of the Foundation to an amount of over $400,000," says the report. "Cash contributions for certain projects have passed through the accounts of the Foundation.

"In addition, other large sums have been contributed by the four founder societies of civil, mining and metallurgical, mechanical, and electrical engineers, and by individuals, corporations, and industry. Likewise, the use of facilities made available by educational institutions and laboratories, and the expert supervision freely donated by many individuals have been of great value.

Civil Service Examination for Welding Inspectors—To fill positions in The Panama Canal, with duty in the Continental United States, the U. S. Civil Service Commission has announced an examination to secure welding inspectors. The salary is $2,600 a year, less a retirement deduction of 3½%. Applications for these positions must be on file with the Commission's Washington office not later than July 29 if received from States east of Colorado, and not later than August 1, 1940, if received from Colorado and States westward.

Applicants must have had experience in the inspection of welding operations on heavy structures or assemblies, which must have included responsibility for quality of workmanship and compliance with prints and specifications. For part of this experience applicants may substitute study completed in a mechanical engineering course in a recognized college, or experience as a foreman supervising the work of welders engaged in welding operations on heavy structures, or certain other appropriate welding experience. Applicants will not be given a written test, but will be rated on their qualifications as shown in their applications and on corroborative evidence.

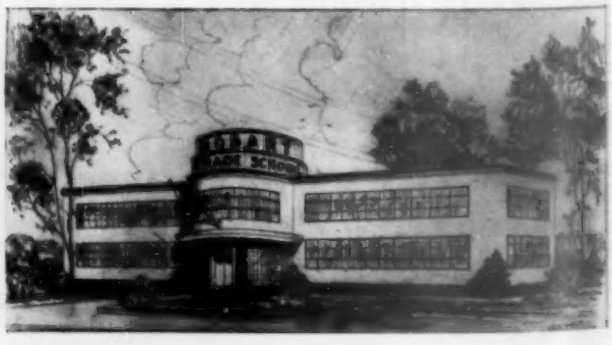
Full information as to the requirements for this examination, and application forms, may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C.

A. F. Davis, of Lincoln Electric Co., was initiated as "Chief Fleetwood", while in Tulsa, Okla., attending the International Petroleum Exposition. R. L. Looney (right) of the Big Three Welding Equipment Co., Tulsa, was first to congratulate "Charlie" Davis.

More than 1000 ft. of butt welds and 1500 plug welds were made in welding Cor-Ten steel deck plates to the girders and track fasteners to the decking at this railroad bridge in Chicago. Photo (General Electric Co.)

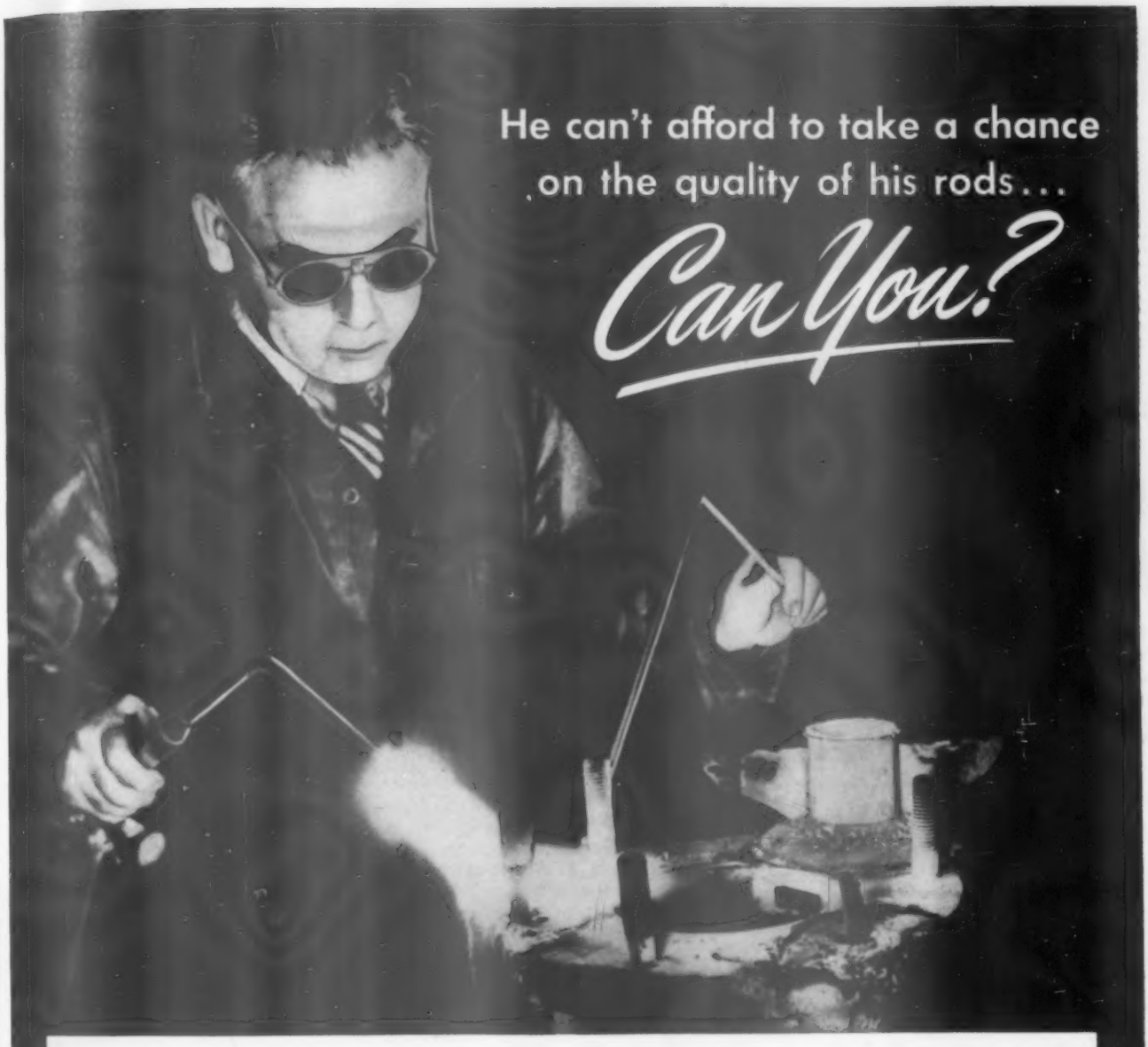
Trade News

Plans Announced for New Hobart Trade School—Officials of the newly-incorporated **Hobart Trade School, Inc.**, operated by the **Hobart Brothers Co.**, Troy, Ohio, have announced that plans have been completed for the erection of a new trade school building—a two-story structure with a frontage of 90 ft. and a depth of 60 ft. The building will be constructed of all-welded steel and can be enlarged at any time that there is need for expansion. **O. H. Menke**, president of the trade school states that the new structure will be ready for occupancy by early fall. The new school is



From architect's sketch of new Hobart Trade School now under construction.

Students in welding school of Lincoln Electric Co., Cleveland, Ohio watching their instructor.



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There are eighteen different Anaconda Welding Rods... a suitable one for every gas or electric bronze-welding purpose. Available through leading distributors. Usually shipped in bulk, but also obtainable in clearly labeled 10-lb. packages. Our new publication B-13, mailed on request. 40121

• • •

Visit the Copper & Brass Industry Exhibit in the Hall of Industry, New York World's Fair, 1940

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JIM, HERE'S A NEW ONE- WELDING MILD STEEL TO STAINLESS. CAN WE DO IT?
I DON'T KNOW BUT ARCOS CAN TELL US.
LATER
THE JOB'S O.K.- CHROMEND HCN ELECTRODES DID IT.
it's ARCOS for welding stainless
FOR INFORMATION WRITE ARCOS CORPORATION Dept. B., 401 N. Broad St., Phila., Pa.

expected to provide complete training in machine shop practice, electric arc welding and other related mechanical lines.

» «

Airco Builds New Plant—In order to extend its servicing facilities to customers in San Francisco and vicinity, the **Air Reduction Co.** has just completed the construction of a new acetylene plant at West Berkeley, Calif. The new plant is located just a short distance from the site of the old plant, and will include all modern equipment for the manufacture of acetylene, the filling, compressing and handling of cylinders.

» «

Westinghouse Quadruples Welding Rod Production—A very modern plant for production of coated rods for electric arc welding is expected to start operation at the Westinghouse Company's East Pittsburgh Works early in July. Employing up-to-date facilities for quality control and rapid production, the new plant will have a capacity about four times as great as the previous output level.

Obituary

William S. Noyes Passes Away—It is with deep sorrow that we report the passing of **William S. Noyes,** vice-president of **Imperial Brass Mfg. Co.,** of Chicago, Ill. His death occurred May 24, 1940, in California. Mr. Noyes, a descendant of an English family which settled in Boston, Mass., in 1632, was born in Boston, August 4, 1869. He was one of the founders of the Imperial company which was organized in 1905. His main activities were centered in the welding end of the business which grew rapidly under his guidance.

Mr. Noyes took an active interest in the many groups and associations formed to promote interest in and knowledge of welding. He served on several committees of the International Acetylene Association, of which organization he was vice-president in 1923-24 and president in 1924-25.

The Air Reduction Company announces with deepest regret the passing away of **Raymond A. Sossong** on Friday, June 28th, at his home in Larchmont, N. Y. Mr. Sossong was Assistant Vice-President and Manager of Gas Plants of the Air Reduction Company, with which he had been connected since 1917.

Mr. Sossong was a graduate of the Carnegie Institute of Technology, class of 1909, and was associated with the Searchlight Company before his affiliation with Airco. He was a Past-President and Director of the International Acetylene Association (1925-26) and was a member of the Compressed Gas Manufacturers Association, the Uptown Club and the Oriente Beach Club.

Mr. Sossong is survived by his wife, Mrs. Wilhelmina Levermann Sossong; a daughter, June; a brother, Andrew C.; and three sisters, Mrs. Elizabeth Ende, Miss Minnie Sossong and Mrs. Frank Mayer.

Personals

Martin J. Conway, who has been fuel engineer for Lukens Steel Co., Coatesville, Pa., since August, 1926, has been transferred to the sales department of the company as special engineer for the petroleum industry. Mr. Conway was born in England and was graduated from Oxford University in 1914 with degrees in mechanical engineering and chemical engineering.

From 1914 to 1920, except for the war years when his activities were directed toward government work, Mr. Conway was in charge of a tar distillation and by-products plant in England. Concurrently, Mr. Conway served as a consulting engineer in handling the design of distillation plants. In 1920, Mr. Conway joined the Pittsburgh Crucible Steel Company, Midland, Pa., as fuel engineer. In 1923, he joined the Steubenville, Ohio, plant of the Wheeling Steel Corp., in a similar capacity.

From 1926 until recently, Mr. Conway has been fuel engineer for Lukens Steel Co.

» «

Dr. Lincoln T. Work, associate professor of chemical engineering at Columbia University, has been appointed Director of Research of the Metal & Thermit Corp., 120 Broadway, New York City. Beginning July 1, 1940, all of the corporation's research and development activities, including work in electric arc and Thermit welding, pigments, metals and alloys and various phases of chemical and metallurgical engineering, will be under his supervision.

Born in Hartford, Conn., Dr. Work was graduated from Columbia University in 1918 and received his degree of doctor of philosophy from there in 1929. He has been successively instructor, assistant professor and associate professor of chemical engineering at Columbia, where he helped to create and establish a process development course, supervised

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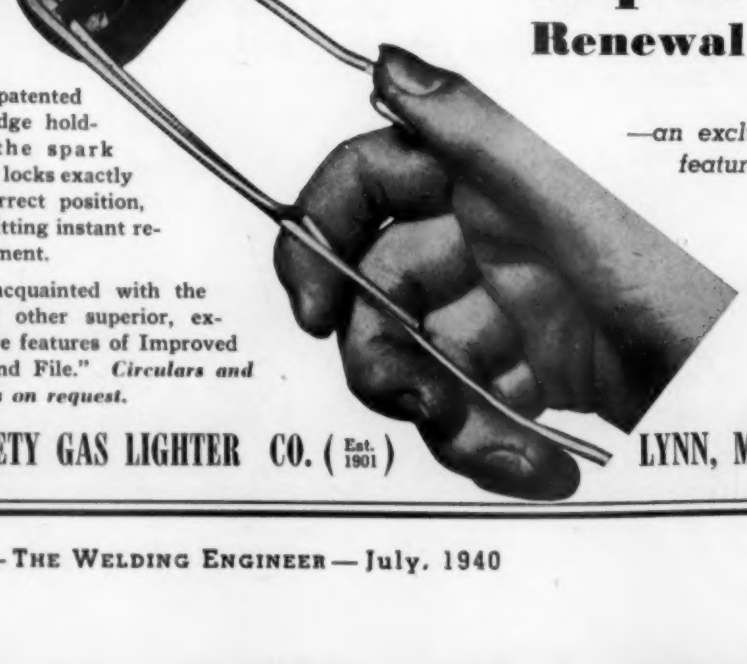

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The patented cartridge holding the spark metal locks exactly in correct position, permitting instant replacement.

Get acquainted with the many other superior, exclusive features of Improved "Round File." ***Circulars and prices on request.***

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chemical engineering thesis projects, organized and directed a course in chemical engineering principles for men in industry and served as assistant to the Director of Extension Teaching and to the Dean of Engineering in charge of the Engineering School's "Men in Industry Program."

Dr. Lincoln T. Work

In addition, Dr. Work has conducted research for a number of industrial concerns in the cement and clay, paint and varnish, air conditioning, plastics, pulp and paper, and pulverized coal fields, and organized a division of fundamental research for one of the country's largest corporations in the chemical engineering industry.

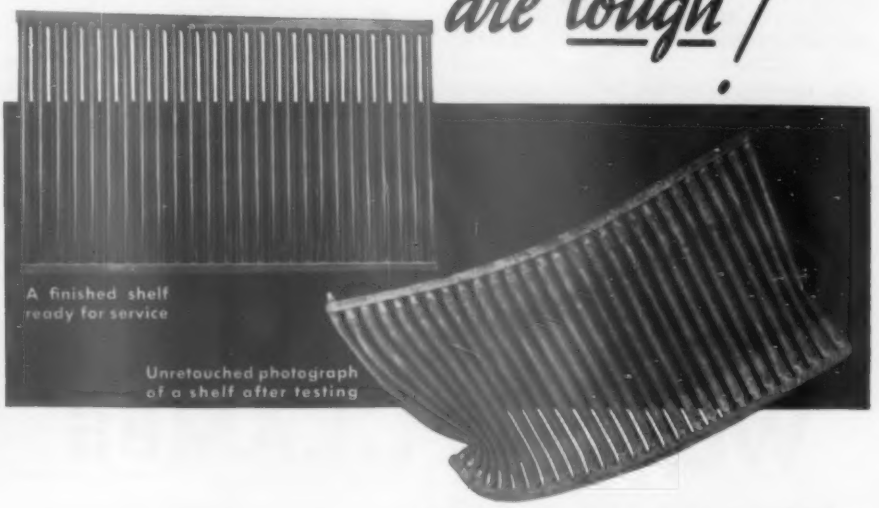
Dr. Work is a member of a number of honorary fraternities and professional societies, including American Institute of Mining and Metallurgical Engineers, Electro-Chemical Society, American Institute of Chemical Engineers, American Chemical Society, Society of Chemical Industry, and American Society for Testing Materials, in many of which he has held various offices and done important committee work. He also is a member of several committees of the National Research Council and the American Standards Association. The American Section of the Society of Chemical Industry has elected him as its chairman for the coming year. He is also the author of a number of publications on chemical engineering subjects.

» «

Norton Co. Executive Changes

Harry K. Clark has been elected vice-president and general manager, and **Andrew B. Holmstrom**, vice-president and works manager of the **Norton Co.**, Worcester, Mass. These appointments were made to fill vacancies caused by two resignations. **Aldus C. Higgins**, president, who also held the office of general manager, resigned the general managership, and **George N. Jeppson**, treasurer and vice-president, who also held the position of works manager, resigned from his position as works manager. Mr. Higgins will retain the office of president and Mr. Jeppson will retain the

More proof that SIL-FOS *brazed joints are tough!*



ALL the copper tubes in these water cooler shelves for refrigerators are joined to headers with the low temperature brazing alloy SIL-FOS.

But before this job was allowed to go into regular production the SIL-FOS brazed joints were given a most severe testing.

The shelf on the right was given a hydrostatic test for leak-tightness far beyond service requirements—then it was crushed as you see it to test joint strength and ductility. Tubes and headers were badly distorted but *every brazed joint still remained sound and leak-tight.*

This is typical of the reliable work SIL-FOS is doing for manufacturers all over the country. Not only does SIL-FOS improve joint quality—it also speeds up production, reduces rejects to a minimum and lowers brazing costs. If you have non-ferrous metals to join, test this effective brazing alloy on your work. Write us now for full details and Bulletin WE-57.

Make a lap joint between two pieces of copper with SIL-FOS, following instructions for cleaning, fluxing with HANDY FLUX and heating as given in our Bulletin No. 1. (Copy on request). Then test the joint as shown above. You will find that the SIL-FOS joint is as strong as the metals joined. For best results always use HANDY FLUX with SIL-FOS.

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offices of treasurer and vice-president.

Mr. Clark has been with the company 25 years, having held the positions of salesman, district manager of the Chicago territory, sales manager of the company's plant in Germany, sales manager of the abrasive division, general sales manager, a director and vice-president. Mr. Clark also is executive officer in charge of **Norton Co. of Canada Ltd.,** a director of **Behr Manning Corp.** of Troy, N. Y., and a director of **Australian Abrasives (Pty) Ltd.,** Sydney, Australia.

Mr. Holmstrom has been connected with the company for 20 years, during which time he has had considerable experience as an engineer and in plant management. After five years in the Norton plant engineering department, 1920 to 1925, he was appointed to the office of superintendent of sewers of the City of Worcester, at a time when the city was installing a large sewage purification plant. When the plant was completed he returned to the Norton Co., later going to England as resident engineer of the **Norton Grinding Wheel Co. Ltd.** at Welwyn Garden City. Two years later he returned to the Worcester plant, but in 1934 went back to England as general manager of the British plant, returning, again to America in 1939 to assume responsibility of works manager of the abrasive division.

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Withstands All Welding and Handling Abuses

Heat treated for long wear. Threads always protected. Retains oil for long period.
Heat treated chrome molybdenum alloy handle offers great resistance to bending.
MAIN FEATURE
NO THREADS TO DAMAGE IN OPEN OR CLOSED POSITION.
WELD SPATTER EASILY REMOVED.
Made from solid steel plate, heat treated, giving great resistance to bending or twisting.
PATENTED

14 STOCK SIZES

Special Sizes and Shapes Furnished for Special Applications

INDESTRUCTIBLE CONCEALED THREADS

Red Head Welding Clamps have been especially designed for welding service. Their construction eliminates the trouble caused by weld spatter or accidental damage to threads. A clamp that will stand up under the most rigorous service over long periods of time.

A trial will convince you. Send for sizes and prices today.

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A.W.S. Activities

New A.W.S. Officers Named by Nominating Committee

The Nominating Committee of the American Welding Society presents the following list of 1940-41 officers for consideration of the entire membership:

President

G. F. Jenks, Colonel, Ordnance Dept., U. S. Army, Washington, D. C.

First Vice-President

K. L. Hansen, Consulting Electrical Engineer, Harnischfeger Corp., Milwaukee, Wis.

Second Vice-President

David Arnott, American Bureau of Shipping, New York, N. Y.

Directors At Large

H. O. Hill, Bethlehem Steel Co., Bethlehem, Pa.

J. H. Deppeler, Metal & Thermit Corp., New York, N. Y.

E. L. Mathy, Victor Welding Equipment Co., San Francisco, Calif.

A. G. Bissell, Bureau of Construction & Repair, Navy Dept., Washington, D. C.

District Vice-Presidents

New York and New England District

P. J. Horgan, General Electric Co., Lynn, Mass.

Middle Eastern District

E. T. Scott, Cleveland School of Welding, Cleveland, Ohio.

Middle Western District

D. H. Corey, Detroit Edison Co., Detroit, Mich.

Southern District

O. T. Barnett, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.

Pacific Coast District

L. W. Delhi, Western Pipe & Steel Co., San Francisco, Calif.

Recent Patents

Resistance Welding

2,202,405. **William E. Smith,** Detroit, Mich., assigned to **The Midland Steel Products Co.,** Cleveland, Ohio. Filed July 1, 1936. Issued May 28, 1940. This patent describes a method of resistance welding of tubular and plate members together which comprises, providing a tapered edge at the end of the tubular member, and forming an opening in the plate member, intermediate to the inside and outside dimensions of the tubular member, the opening having walls that are generally parallel. The tapered ends of the tubular member is then brought into aligned and continuous contact with the edge of the plate opening. The portion of engagement between the two members is raised to welding temperature by an electric current and then, by the application of pressure, the members are fused together.

Flexible Pipe Nozzle

2,203,210. **Lloyd W. Young,** Scotch Plains, N. J., assigned to **Oxweld Acetylene Co.,** of West Virginia. Filed April 21, 1939. Issued June 4, 1940. A blowpipe which has a removable head and a flexible nozzle is the subject of this patent. The patented pipe is shown as applied to a cutting blowpipe. However, the structure appears to have value in welding pipes as well.

» «

Welding Power Shafts

2,203,319. **James L. Anderson,** Closter, N. J., assigned to **Air Reduction Co.,** New York, N. Y. Filed July 13, 1937. Issued June 4, 1940. In order to produce a strong and reliable weld in tubes used for power transmitting shafts and the like, it is necessary to have at least a superficial melting of the edge faces which come together to make the weld. However, when the fused stock hardens, the grain structure is that of cast metal. The inventor eliminates the melted metal from the weld by displacing the edge portions toward one another after the edge faces come into contact. The displacement is so proportioned to the heating and fusing that substantially all of the molten metal is squeezed out of the seam between the edge portions. The flash is removed by a cutting tool, the welding and flash removal being carried out as a continuous operation. In making welded tubes, sets of rolls are employed for welding and for pressing the edges of the stock metal together.

» «

Weld Rod

2,204,412. **Josef Hinnuber,** Essen, Germany, assigned to **General Electric Co.,** of New York. Filed April 15, 1938. Issued June 11, 1940. It is the purpose of this patent to prepare a sintered weld rod which is made up of 27 parts powdered iron, 16 parts ferro-chrome, 3.2 parts powdered ferro-manganese, 1.5 parts ferro-silicon, 2.3 parts powdered carbon and 50 parts of presintered hard metal, the hard metal consisting principally of tungsten carbide. The resultant metal has wear-resisting properties.

» «

Electrode Holder

2,204,545. **John H. Faunce,** Johnstown, Pa. Filed Mar. 20, 1939. Issued June 18, 1940. For automatically moving a welding electrode along a seam to be joined, a holder is provided which is pivoted at one end and carries the weld rod at the other end. The weld rod is held by a clamp in the holder above the work, so that the rod is at an oblique angle to the work pieces. As the rod is used and becomes shorter gravity alone is effective to progressively advance the rod along the line of weld. A stop screw is provided for stopping the movement of the rod at any predetermined position. This stopping position can be readily predetermined by attaching a dummy rod in the holder before the current is turned on. By properly setting the angle of the welding rod and by setting the stop screw at a desired finishing point, the length of the seam weld can be controlled. By means of such a holder a single workman may accomplish a number of welding operations simultaneously, the only attention needed being the adjustment of the rod angle and the stop movement of the pivoted holder.

» «

Angle Nozzle Blowpipe

2,204,756. **Frank C. Hasse,** La Grange, Ill., and **Lloyd W. Young,** Scotch Plains, N. J., assigned to **Oxweld Acetylene Co.,** of West Virginia. Filed April 5, 1938. Issued June 18, 1940. This invention relates to a blowpipe including a head having seating surfaces and a nozzle normally detachably secured to the head, the nozzle having seats to engage the surface of the head. An adaptor unit is designed to be placed between the head and the nozzle, and is adapted to permit the axis of the nozzle to be angularly adjusted with respect to the axis of the head. Continuously drilled passages are provided through the adaptor to enable the gases to reach the nozzle.

» «

Butt Welding Machine

2,204,858. **Edwin B. Hudson,** Middletown, Ohio, assigned to **The American Rolling Mill Co.,** Middleton, Ohio. Filed Oct. 27, 1938. Issued June 18, 1940. In the resistance welding of strip up to 90 in. in width, the welding machine must be provided with equipment to push up a weld having a large cross-sectional

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TITAN BRONZE WELDING ALLOYS

area. In addition a suitable gauge must be employed for spacing the welding gap. The inventor provides a rigid gauge to obtain proper spacing of the strip ends. In addition, the apparatus carries out the welding operation in such a way that the strip ends are moved in a direction transverse to the plane of the strip. The welder has electrodes which move downwardly with the strip in an angular direction and toward each other at the same rate during the welding cycle. The electrodes and clamping jaws are in the receiving position at the same time that the fixed gauge obstructs passage of the strip through the machine to facilitate the relative positioning of the strip ends. The actual ends of the strip can be observed in gauge position before the welding operation is started. The inventor departs from the conventional machine in that the strip ends are brought squarely against a rigid gap spacing gauge in a horizontal plane above the plane of normal strip travel.

» «

Tank Welding

2,205,002. **John P. Tripp,** Montreal, Canada. Filed March 7, 1938. Issued June 18, 1940. The purpose of this patent is to provide a compact, self-contained machine by which seam welding operations, particularly the longitudinal seam welding of pipes and tanks, may be easily and quickly accomplished without the assistance of overhead cranes, hoists or other lifting devices. The machine is provided with a work-transporting truck which serves to push the cylindrical work piece onto an elevated, horizontally extending work-supporting arm, to which the work is fastened during the seam welding operation.

» «

Resistance Line Welding

Robert T. Gillette, Scotia, N. Y., assigned to **General Electric Co.** of New York. Filed July 21, 1938. Issued June 18, 1940. In resistance line welding, the parts to be welded are subjected to pressure and current applied by electrodes which engage the work. In performing resistance line welding, it is difficult to secure a satisfactory weld without burning, pitting, or grooving the surface of the work parts that make engagement with the electrode or electrodes moved relatively to the work. This is due primarily to excessive surface temperatures resulting from the current densities which occur at the point of engagement of the electrode with the work. For example, the usual roller electrode makes essentially a line contact with the work, and the heating current must pass through this restricted area, while the weld is being made between the work parts over a much greater area. This effect has been overcome by rapidly making and breaking the welding circuit, or by periodically decreasing the welding current to a low value. Such practice does not prove satisfactory on work pieces which are relatively thick, that is ⅛ in. or more. According to the invention thick pieces may be welded if the electrode and the work are traversed relative to one another with an intermittent or step-by-step movement, while continuously supplying heating current which is periodically varied in magnitude at a rate such that a welding heat is built up between the work parts only during periods of rest in the intermittent movement. This relative step-by-step movement may be obtained by interruption of the current used for moving the work pieces. A ratchet movement may also be employed.

Trade Literature

Welding Electrode Chart—A chart just issued by **The Lincoln Electric Co.,** Cleveland, Ohio, indicates that there is now available an arc welding electrode for welding practically every conceivable job. The chart, in attractive design and color, gives uses, physical characteristics, etc., as well as currents and procedures for some 36 different electrodes.

The chart should be of value to shop executives using welding. It should also be of value to designing engineers since physical characteristics of weld metals are given. Copies of the chart are available by writing to The Lincoln Electric Co., Cleveland, Ohio, on business letterhead.

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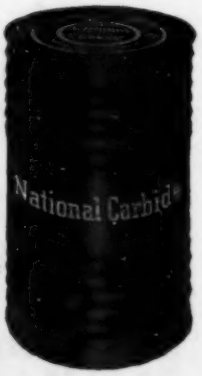

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Welded Steel Barges—A comprehensive bulletin just prepared by **Dravo Corp.**, Pittsburgh, Pa., tells an informative story regarding the use, design and construction of welded steel barges. The treatment is both narrative and explanatory, and 84 photographs illustrate the text. Twenty types of barges, covering both harbor service and river transportation, as well as a number of river towboats, derrick boats, dump scows and ferry flats are described.

The booklet begins with a review of Dravo facilities and there are photos of the Pittsburgh, Pa. and Wilmington, Del. shipyards. A section on barge design features towing efficiency which results from scientifically engineered and pretested hull and rake end designs. Results of some of the model basin tank tests involving various rake end shapes which Dravo Corp. has sponsored also are shown.

Next discussed are the structural details which give ruggedness and damage-resisting strength to welded steel barges. How the rounded corners and headlog are reinforced and given ability to "take it" in the hardest service; serrated framing; patented Dravo skegs to prevent yawing of barges that are towed astern; rolling hatch covers for weather-proof cargo transport—these and other details are described for the information of barge users.

The fabrication and assembly of welded hulls is reviewed in some detail. The arrangement of facilities is a unique adaptation of the line assembly method of production so characteristic of the manufacture of consumer goods. Many of the Dravo positioning devices and welding routines are here illustrated.

Requests for the bulletin (No. 213) should be addressed to the Dravo Corp., 4600 Neville Island, Pittsburgh, Pa.

» «

Story of Alloy Steels—The story of alloy steels, those tough, sturdy steels demanded by modern industry, is told in a sound motion picture film recently produced by the U. S. Bureau of Mines in cooperation with an industrial concern. The film, entitled "Alloy Steels—A Story of Their Development," is in 16- and 35-mm. widths and requires 20 minutes for showing.

This new film may be obtained for exhibition purposes by schools, technical societies, clubs, civic and business organizations, and others interested by applying to the Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa. It should be stated whether 16- or 35-mm. width is desired. No charge is made for the use of the film, but the exhibitor is expected to pay transportation charges.

» «

"Airco Electric Welding Products," a 32-page illustrated booklet, just issued by Air Reduction, describes the complete line of Airco electrodes and Wilson electric welding machines. The booklet discusses various types of electrodes and offers suggestions as to where each type can be used to best advantage. Included in the description of each electrode is (1) a general description; (2) suggested applications; (3) welding procedure; (4) physical properties; (5) specification table.

Another section of the catalog is devoted entirely to electric welding accessories. Among the items covered are aprons, brushes, cable, graphite electrodes, face shields, leather gloves, goggles, helmets, electrode holders and many others. The products in this section are conveniently arranged for quick reference.

The concluding section offers a detailed discussion of various Wilson electric welders—The "Hornet", "Yellow Jacket", Model MCT, and Model GA, Copies of this catalog, No. 103, can be obtained by writing to Air Reduction Co., 60 East 42nd St., New York City.

» «

Sil-Fos and Easy-Flo—Handy & Harman, 82 Fulton St., New York City, have just released a four-page illustrated folder describing industrial applications of their Sil-Fos and Easy-Flo brazing alloys. In this folder it is pointed out that when these low-temperature brazing alloys are used, it is possible to obtain joints that are as strong as the metals joined and that considerable labor and material cost savings are realized. Production is also speeded up. Additional savings are realized in finishing operations and rejects are very low. The cost per joint is said to be surprisingly low.

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For Sale—Will sell my 150 amp. Hobart 230-volt A-C. electric drive welder practically new for $155; Also new Pierce belt type governor at $20; Have 400 ft. No. 1 extra-flexible cable, 250 amp. size at only 16c ft. Address Ted Tellman, 15815 Euclid Ave., Cleveland, Ohio.

For Sale—300 amp. Lincoln 230-volt driven portable type. Excellent condition at $240; Also have 400-amp. Hansen gas engine welder, good shape at $325; Also Lincoln 200-amp. 220/3/60 welder with shaft extension rebuilt recently $195; Pierce governor $17. Address, Stoffer, 3724 W. 64th Pl., Chicago, Ill.

For Sale—Factory excess stock new welding cable rubber-covered super-flexible type. 200-amp. No. 2 size, 1666 strands, 15c ft.; 250-amp. No. 1 size, 2156 strands, 17½c.; 300-amp. No. 1/0 size, 2646 strands, 20c ft. Address July 3, The Welding Engineer.

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Instructor to teach welding and assist in machine shop in engineering college. Salary $1800 for academic year. Apply, giving qualifications and small photograph, to Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pa.

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Experienced welder desires position as instructor. Formerly foreman and instructor in Grigsby-Grunow plant, training students in hard and soft soldering. Well-informed, reliable. Address Joseph Darby, 1010½ N. Broadway, Oak Park, Ill.

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